



**Integration of  
building information modeling and lean construction,  
a suitable solution for managing megaprojects**

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## Problem Statement

- Projects are implemented with unexpected variance, overlapping execution, and commitment gap (Bourne, 2006; Nokes and Kelly, 2007).
- The lack of formal stakeholder management in projects and the weaknesses of the qualitative methods of stakeholder management are two important issues that are reported in the literature (Aladpoosh, et al., 2012).
- Many projects were plagued by cost and time overruns because of poor information sharing and lack of coordination among the participants (Doloi et al., 2012; and Mahalingam et al., 2015)
- Project success is linked to the strength of the relationships with all members of the project's stakeholder community (Bourne, 2006; Bourne and Walker, 2005).



## Problem Statement

- Megaprojects are composed of individual project groups. The objective of each group differs from the others. Thus, conflicts in resources & schedules among them are the main features in managing megaprojects (Li, M. et al., 2021).
- Early researchers have identified that people management factors drive project success more than technical issues (Pinto and Prescott, 2007; Abdullah et al., 2006).
- In spite of most evident advantage of BIM is information management and LC is management optimization; only a few studies have examined the approach of simultaneously using BIM and LC in megaprojects (Li, M. et al., 2021).
- Whether BIM and LC can work together in megaprojects and whether they can be integrated for use in projects? However, lack of experience on the integrated usage of BIM and LC in megaprojects is reported.

## Megaprojects, definition

- Megaprojects are projects that are generally considered to cost from 500 million to 1 billion USD when specific factors, such as scale, complexity, and social impact, are considered (van Marrewijk et al., 2008).
- Megaprojects possess a long lifespan, involve complex management, and have considerable uncertainty (Bruzelius et al., 2002).
- Megaprojects are large, complex, & typically affect millions of people (Flyvbjerg, 2017).
- Total global megaproject spending is assessed, at \$6-9 trillion annually, or 8% of total global GDP, which denotes the biggest investment boom in human history (2014, Bent Flyvbjerg).

## Megaprojects, break-fixed

- In general, megaprojects are systematically subject to "survival of the un-fittest," and the worst projects get built instead of the best (2014, Bent Flyvbjerg).
- It is argued that the conventional way of managing megaprojects has reached a "tension point," where tradition is challenged & reform is emerging (2014, Bent Flyvbjerg).
- Traditional project management methods cannot handle the complexity, specificity, and uncertainty of megaprojects (NewAnsah et al., 2016).
- Although many studies on megaprojects have been conducted and many achievements have been attained, numerous problems remain (Hu et al., 2015).
- In the literature, the difficulties encountered in megaprojects is divided into management and technical problems (Li, M. et al., 2021).

## Megaprojects, difficulties

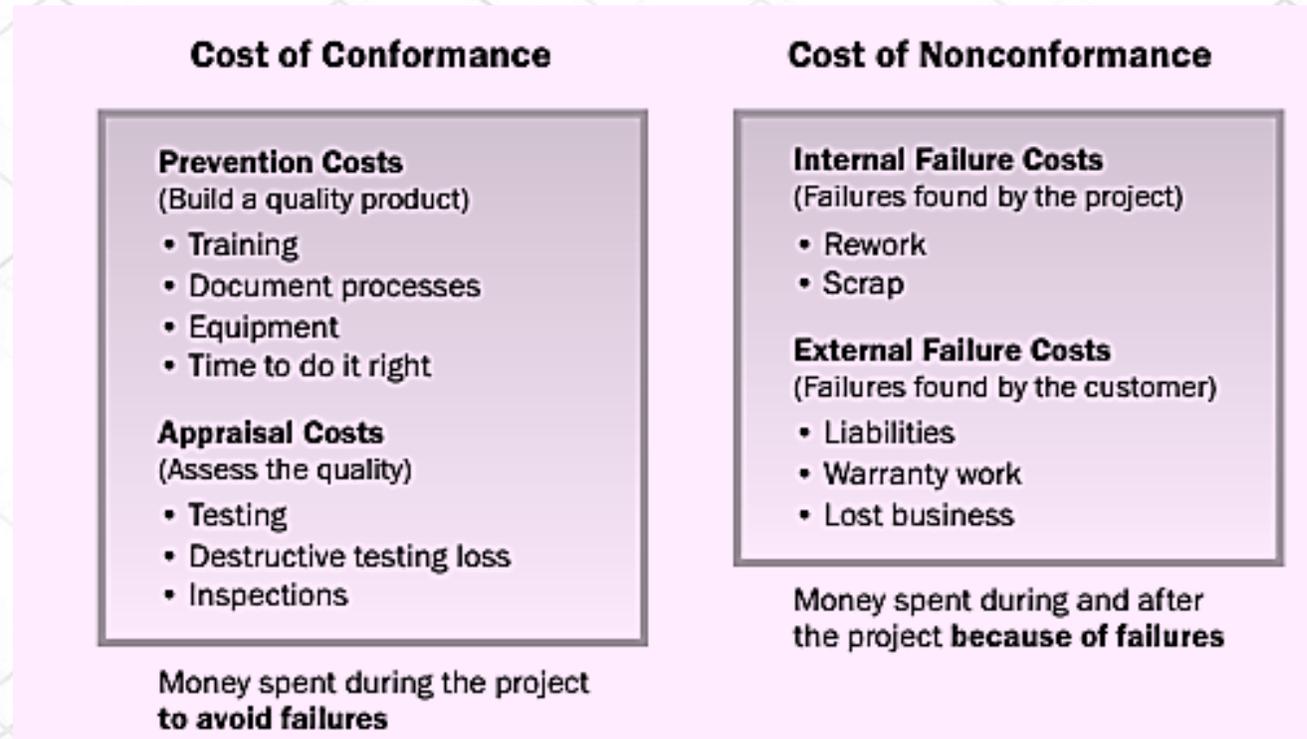
Category	Main problems	Description
<b>Management</b>	Organization management	Numerous project participants, complexity in administrating levels, vertical connection is cumbersome and lacks horizontal connection
	Information management	Many engineering data sources, complex communication between participants, information transmission distortion
	Coordination management	Heavy workload in coordinating division of labor, resource allocation, and project objectives among functional departments
<b>Technology</b>	Difficulty in construction	Numerous applications of new structures, materials, and technics
	Complex building structure	Architectural modeling and spatial relations are complex, while structural forms are complex and diverse
	Schedule control	Short construction period, substantial crossover work, and numerous engineering changes

**Li, M., Ma, Z. & Tang, X. (2021)**

## Cost of Quality (COQ)

- All costs incurred over the life of the product by investment in preventing nonconformance to requirements, appraisal of the product or service for conformance to requirements, and failure to meet requirements.

(PMBOK 7<sup>th</sup>, 2021)





## Relevant solution

- ✓ It is expected that, the integration of BIM and LC can improve management performance and achieve high quality standard for the management of megaprojects.

(Li, M. et al., 2021).

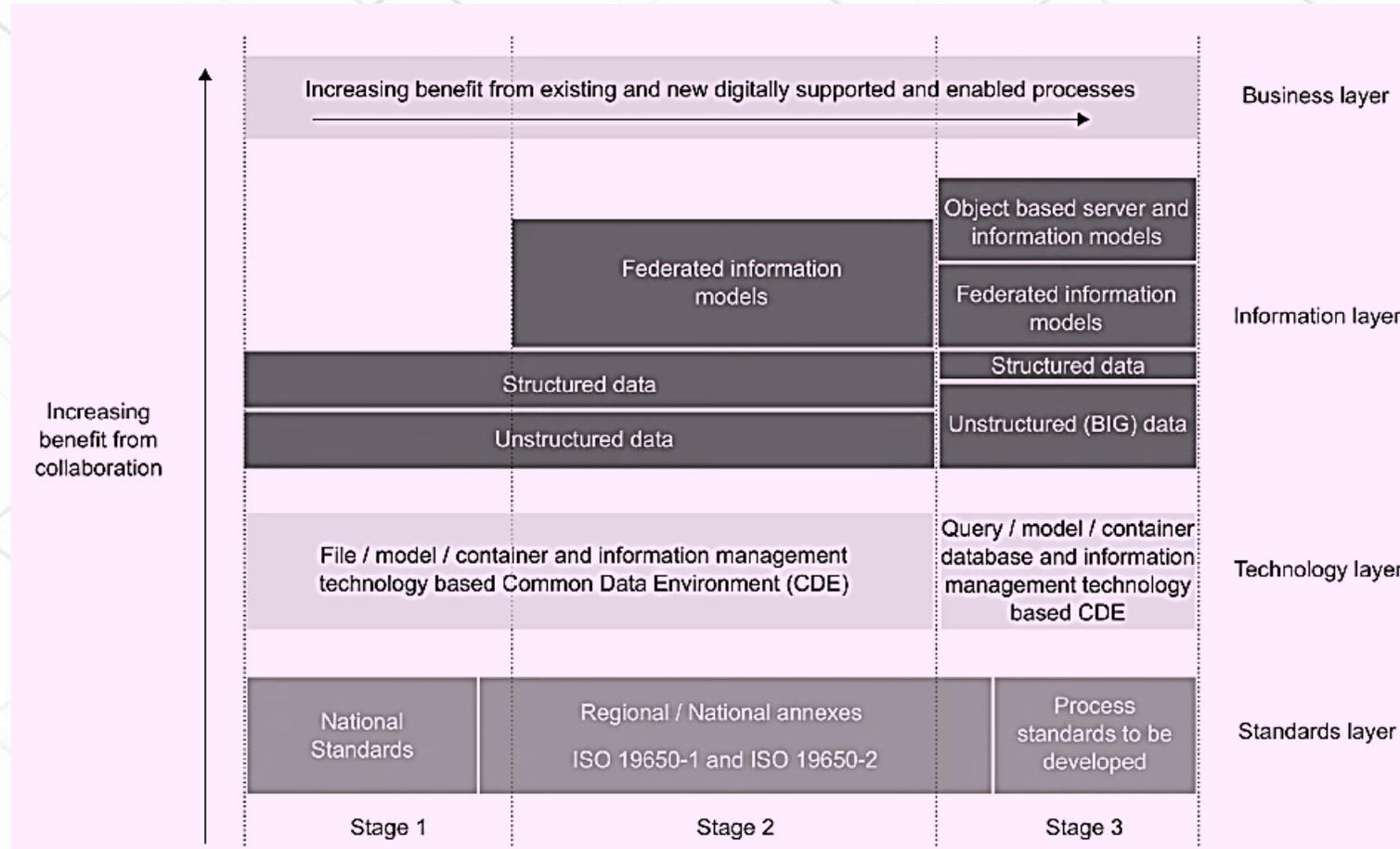
- ✓ This presentation aims to illustrate a BIM-based LC application method for megaprojects.



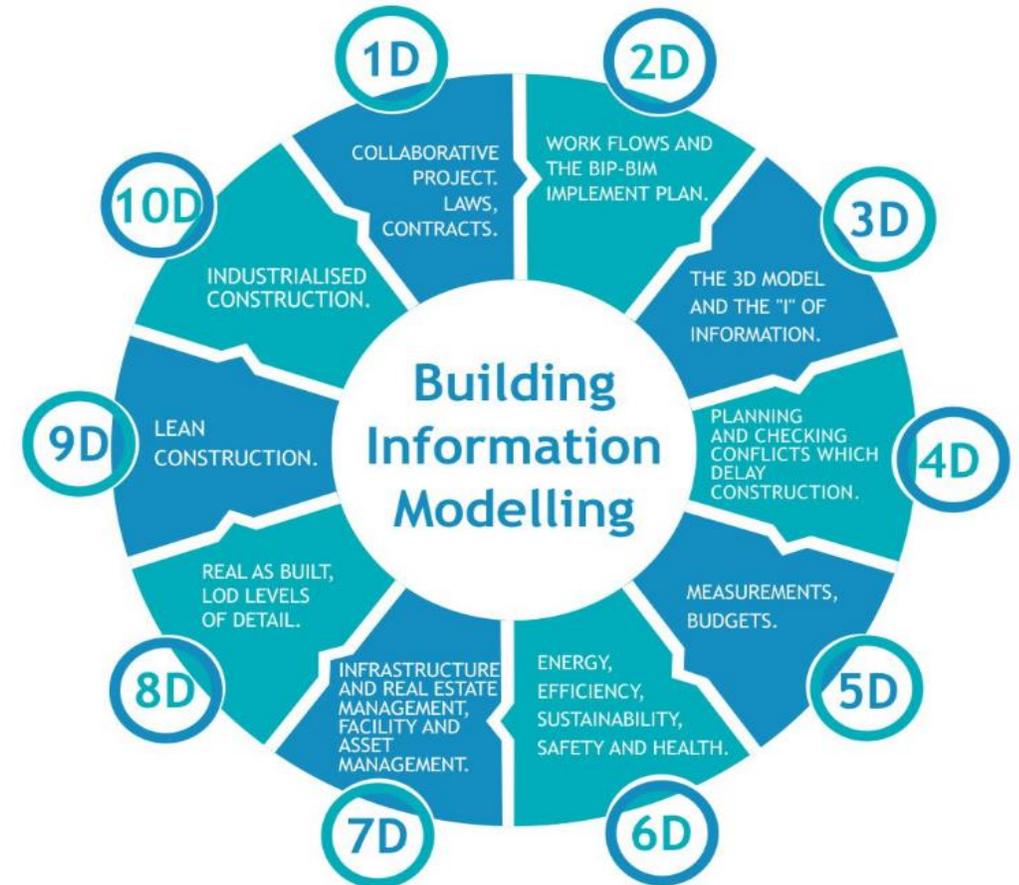
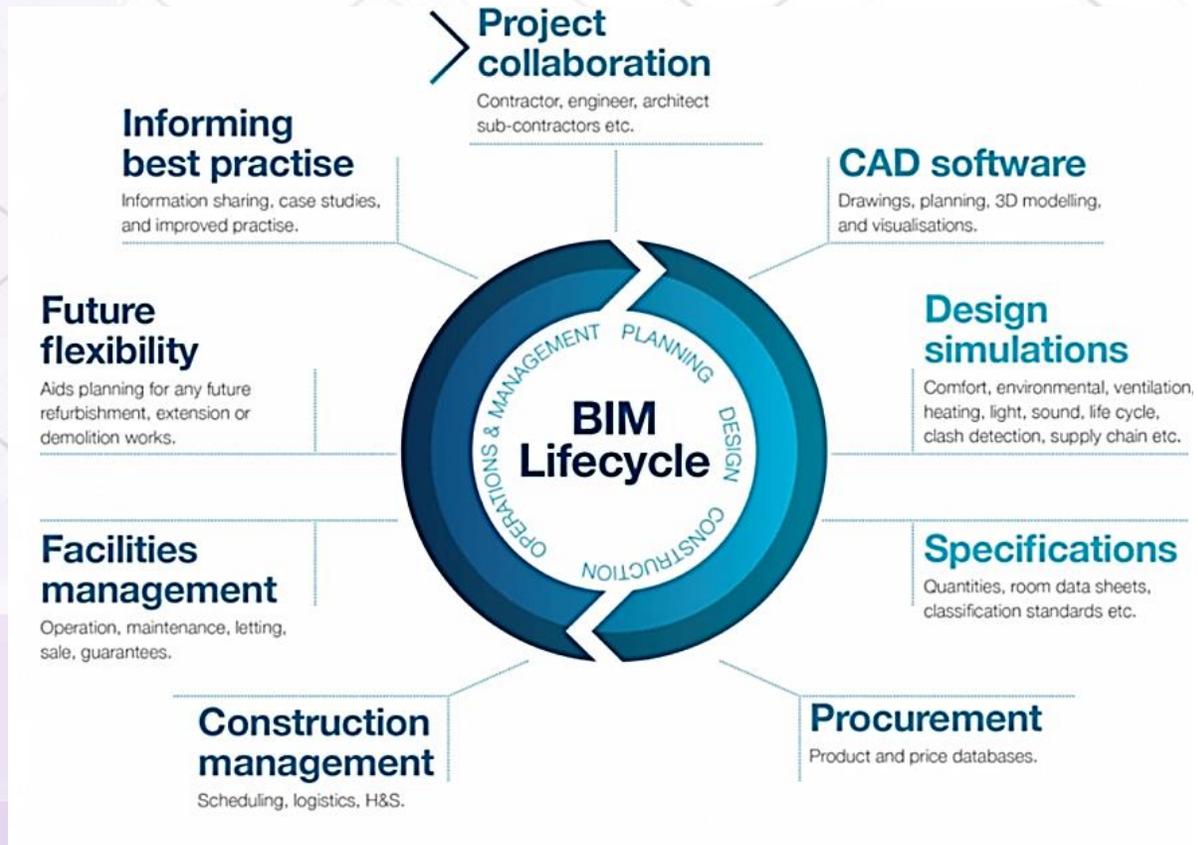
# Building Information Modeling scope in brief



- BIM is a process of designing, constructing or operating a building or infrastructure asset using electronic object-oriented information.



# BIM Lifecycle, Dimensions





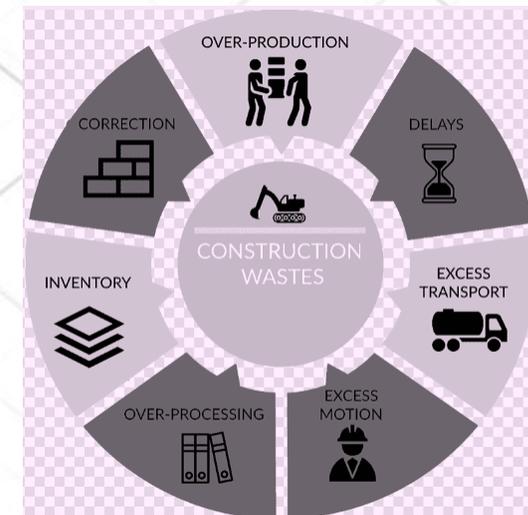
## Applicability of BIM in projects

- BIM is frequently used as a tool for coordinating project information with project management in construction projects (Deutsch, 2011).
- BIM allows all stakeholders and participants in a project to utilize coordinated, reliable information from the beginning of the project (Azhar, 2011).
- BIM method can improve quality, shorten construction duration, and improve collaboration among project participants, thereby enabling mega-skyscrapers to be built safely and efficiently (Soh, 2014).



## Lean Construction scope in brief

- LC is a way to design and build capital facilities.
- LC challenges the generally accepted belief that there is always a trade between time, cost and quality.
- LC focuses on:
  - Maximizing value and minimizing waste
  - Concurrent engineering of facility and workflow
  - Value to owner defined and refined over time
  - Continuous flow of work schedules
  - Decentralized decision making, transparency, empowerment





## Differences between “LC” & “PMI” approach to construction

- In LC, managing the interaction between activities & combined effects of dependence & variation is a first concern, because their interactions highly affects the time and cost of projects. These interactions are not considered in PMI.
- In LC, optimization efforts focus on making work flow reliable; PMI focuses on improving productivity of each activity which can make errors & reducing quality & result in rework.
- In LC, project is structured & managed as a value generating process (value is defined as satisfying customer requirements). PMI considers less cost as value.
- In LC, downstream stakeholders are involved in front end planning & design through cross functional teams. PMI doesn't consider this issue.
- In LC, project control has the job of execution; but control in PMI method relies on variance detection after-the-fact.
- In LC, pull techniques govern the flow of information & materials, from upstream to downstream; in PMI, push techniques govern the release of information & materials



## Differences between “LC” & “PMI” approach to construction

- Capacity and inventory are adjusted to absorb variation (Mura). Feedback loops, included at every level, help ensure minimal inventories and rapid system response. PMI doesn't consider adjustments.
- In LC, tries to mitigate variation in every aspect (product quality, rate of work) and manage the remaining variation. PMI doesn't consider variation mitigation and management.
- In LC, tries to make continuous improvements in the process, workflows and product. PMI doesn't pay that much attention to continuous improvement.
- In LC, decision making is distributed in design production control systems. In PMI decision making is centered to one manager some times.
- In LC, tries to increase transparency between the stakeholders, managers and laborers, in order to know the impact of their work on the whole project. PMI doesn't consider transparency in its methods.

## Applicability of LC in projects

- Lean Construction is a management method that relies on production management principles and its goal is to meet customer needs while using minimal resources (Sacks et al., 2009).
- The essential features of LC include clear objectives, waste elimination, satisfaction of customer needs while ensuring maximum performance (Sacks et al., 2010a) and control throughout the entire lifecycle (Best and de Valence, 2002; Rahman et al., 2012).
- LC method is a robust means of project management, can help address project complexity via lean principles & can enhance performance (Ansah et al. (2016).
- LC begins from the initial stage of a project to the handover of a facility to the client (Best and de Valence, 2002).
- The focus of LC is often to reduce waste, increase customer value, and seek continuous improvement (Sacks et al., 2009; Koskela et al., 2010).
- The Lean Construction Institute reported that approximately 57% of productive time waste could be found in the construction industry (Ansah et al., 2016).

## Applicability of LC in projects

- LC essential features include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design, construction, & the application of project control throughout the life cycle of the project from design to delivery.
- LC approaches, such as last planner system (LPS), visible management (VM), conference management (CM), just-in-time technology (JIT), concurrent engineering (CE), total quality management (TQM), and 6S on-site management (6S) are applied to project processes (Koskela et al., 2002; Li et al., 2017b).
- LC is a value-optimizing management tool for owners, architects, designers, engineers, constructors, suppliers, and end users. This tool aims to eliminate all non-value-adding processes in the system (Ashworth, 2013), while any participant who uses LC aims to add value to projects while avoiding additional costs.



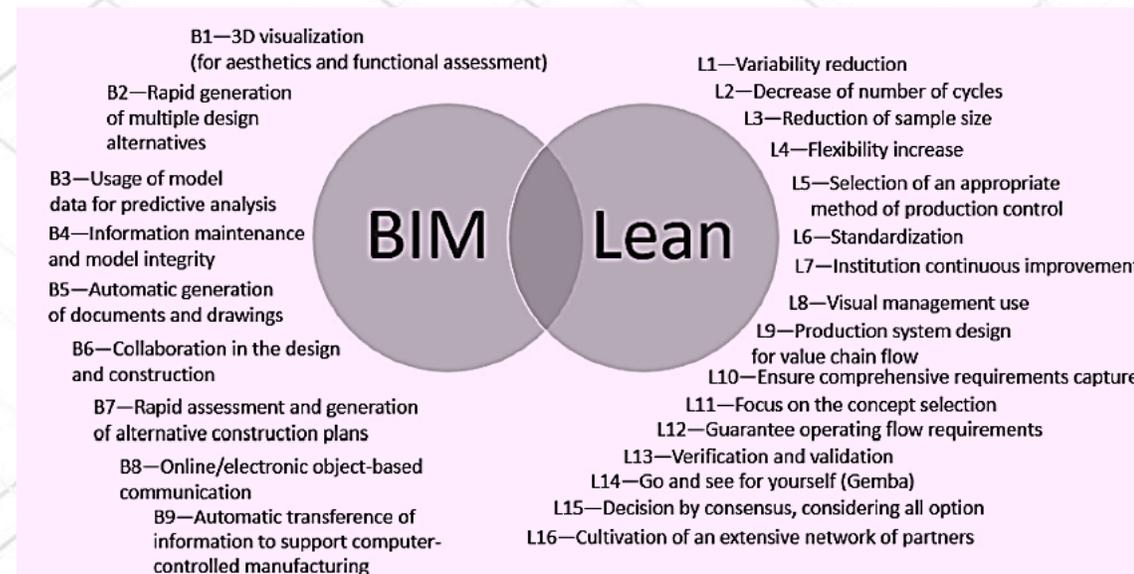
## Integration of BIM and LC

- BIM is a transformative information technology and collaborative visualization tool, while LC is an advanced approach for the management of construction projects.
- When they apply in projects, the two approaches have a similar goal (Villa et al., 2017) of adding value and eliminating waste. Thus, synergy exists between the two methods (Rischmoller et al., 2006).
- BIM could address LC management in a visual manner and proposed an enhanced LC management system to generate a smooth information flow, thereby ensuring efficient production management and control (Dave et al. 2016).
- BIM is expected to provide a foundation for the results that LC is expected to deliver (Sacks et al., 2010).
- BIM is a digital platform through which project teams could share information effectively; when coupled with LC, BIM can effectively improve project performance (Mahalingam et al. 2015).

## Integration of BIM and LC



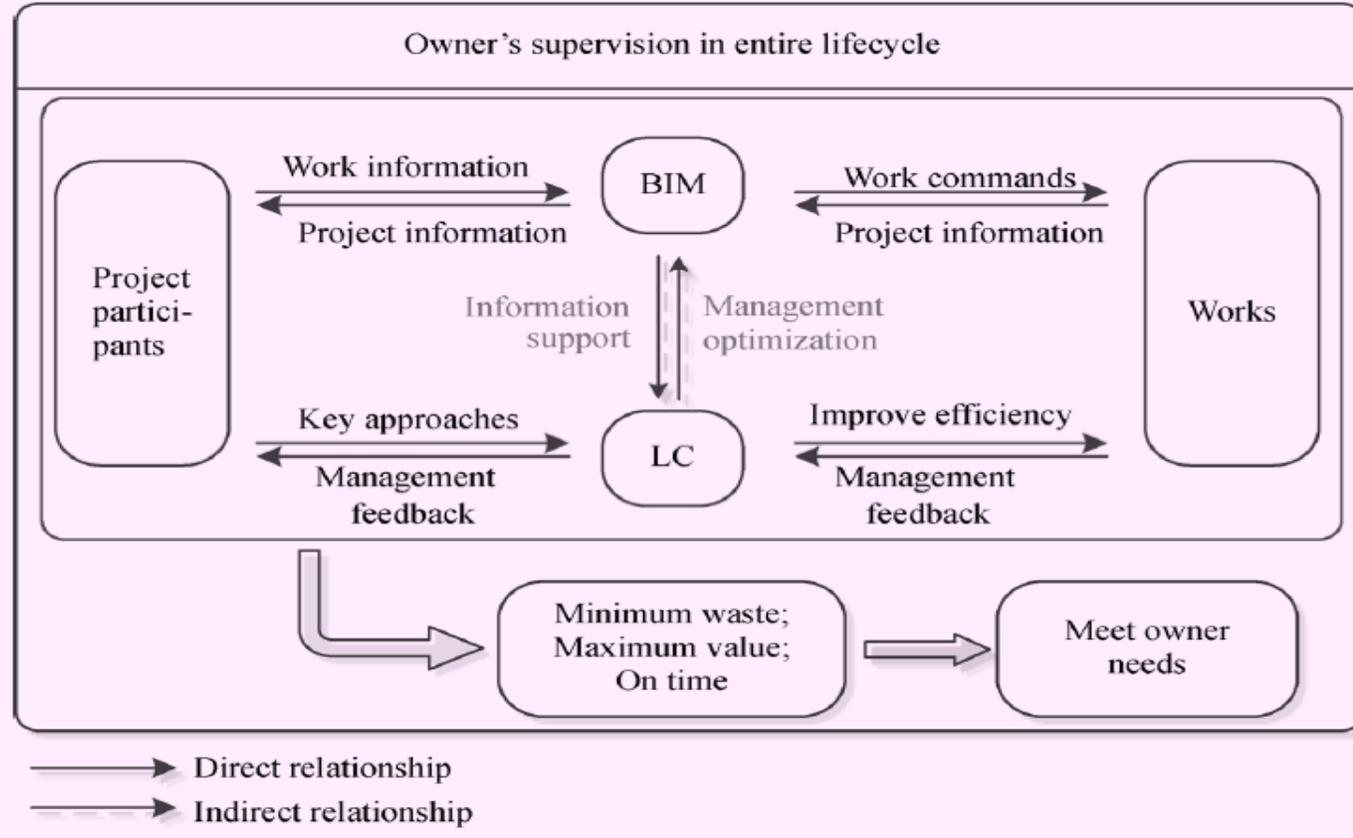
- When BIM and LC are used in the entire lifecycle, then the undesirable phenomenon of being separate and non-continuous in different project phases – EPC – that are often independently executed can be addressed.
- The best way for BIM and LC to be accepted in a project is when the owner imposes these methods in the contract, even though the owner does not play a vital role in its implementation (Porwal and Hewage, 2013).



BIM functionalities and Lean principles. Sacks et al. (2010)



# Integration framework of BIM and LC

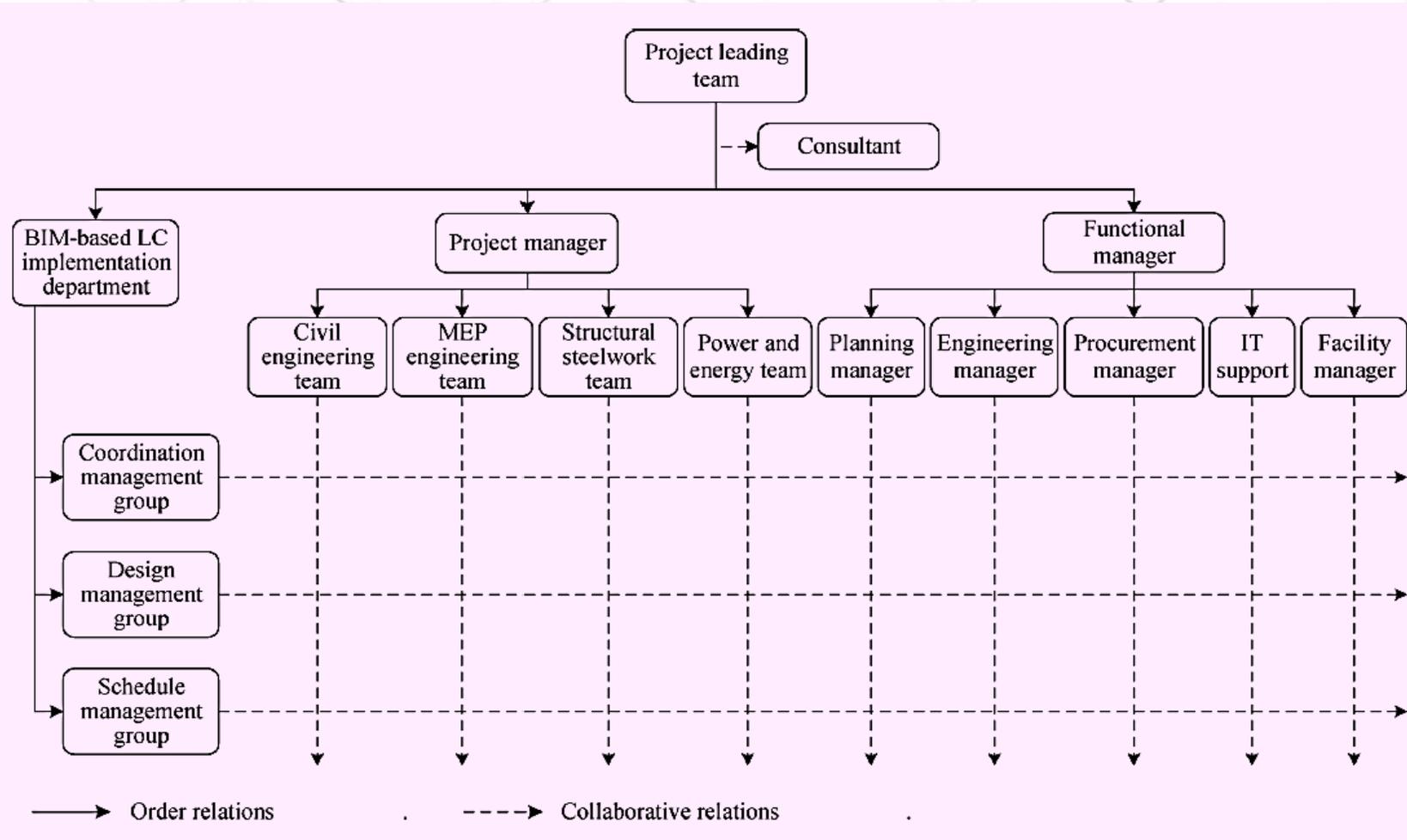


**Li, M., Ma, Z. & Tang, X. (2021)**

When participants deal with project work, BIM and LC affect each other indirectly and are beneficial to completing the work with minimum waste, maximum value, and no delay. The expected result of this framework is that all participants reach the goal of meeting customer needs.



# Organization structure of integrated BIM & LC framework





## Conclusion

- BIM features can address the difficulties in megaprojects from the theoretical and practical perspectives and that BIM is a valid technology that facilitates the achievement of the required outcomes of megaprojects.
- LC is applicable to megaprojects because of this method's features that correspond to the complexity and underperformance of such projects.
- Instead of applying BIM and LC independently, integrating the BIM features with lean principles would bring substantial benefits to the management of megaprojects.
- BIM and LC can be integrated in construction projects and they are advanced tools for project participants.
- However, no one-size-fits-all method/solution is available to solve all the problems of megaprojects.



## Reference

- 2021, The Institution of Structural Engineers BIM Panel, “An introduction to Building Information Modelling (BIM)”, ISE press.
- 2021, Li, M., Ma, Z. & Tang, X. Owner-dominated building information modeling and lean construction in a megaproject. *Front. Eng. Manag.* **8**, 60–71.
- 2021, Project Management Institute, “A Guide to the Project Management Body of Knowledge”, seventh edition, PMI press.
- 2014, Bent Flyvbjerg, “What You Should Know about Megaprojects & Why: An Overview”, *Project Management Journal*, vol. 45, no. 2, April-May, pp. 6-19.
- 2013, Remon Fayek Aziz Sherif et al., Applying lean thinking in construction and performance improvement, *Alexandria Engineering Journal*. Volume 52, Issue 4, 679-695.
- 2012, H. Aladpoosh, A. M. Shaharoun, and M. Saman, "Critical features for project stakeholder management: a systematic literature review," *International Journal of Applied Systemic Studies*, vol. 4, no. 3, 150-167.

**Thank you for your attention**