

Lean Construction and BIM: Complementing Each Other for Better Project Management

Eroshkin S.Y.,

*PhD, associate professor at Department of projects and programs management,
Plekhanov Russian University of Economics, Moscow, Russian Federation
Eroshkin.SY@rea.ru*

Kallaur G.Y.,

*PhD, associate professor at Department of projects and programs management,
Plekhanov Russian University of Economics, Moscow, Russian Federation
kallaur_galina@mail.ru*

Papikian L.M.,

*Assistant teacher at Department of projects and programs management,
Plekhanov Russian University of Economics, Moscow, Russian Federation
lusine.pm@gmail.com*

Abstract. Recently lean construction concept and building information modeling (BIM) have become one of most mainstream tools for solving many project management problems in construction. Thus, the purpose of this article is to investigate opportunities of increasing project management efficiency in construction by integrated use of lean construction principles and building information modeling. Results of contemporary research on lean construction and BIM were inspected. Analysis and synthesis methods were used to achieve the goals of this research. Knowledge of project management methodology was combined and matched to the known tools of lean construction and BIM to generate ways in which the latter can contribute to more efficient project management in the era of knowledge-based economy and rise of information technologies. The research has shown that the vast majority of lean construction principles can be practically realized with the use of BIM (eight of them – fully, four – partly, another four – none). The authors systematized the benefits of simultaneous application of Lean and BIM in existing knowledge fields of project management (project quality, risks, cost, time, scope, human resources, communications, procurement and stakeholders management). Lastly, the consequent link from lean principles to BIM to project management objectives and to overall business success were shown. The presented results correlate with ideas mentioned in most research on the topic. However, it is seen that more emphasis in the article unlike other research were put on the specific opportunities of lean and BIM application for project management. Thus, the results can be useful for further research of academics (especially in Russia, where this topic isn't covered enough) as well as for project managers and other specialist in construction industry.

Keywords: BIM, lean construction principles; project management; construction; integrated use; benefits.

Бережливое строительство и BIM-модель: дополняя друг друга для более эффективного управления проектами

Ерошкин С.Ю.,

канд. экон. наук, доцент, кафедра управления проектами и программами,
Российский экономический университет имени Г.В. Плеханова, Москва, Россия
Eroshkin.SY@rea.ru

Каллаур Г.Ю.,

канд. экон. наук, доцент, кафедра управления проектами и программами,
Российский экономический университет имени Г.В. Плеханова, Москва, Россия
kallaur_galina@mail.ru

Папикян Л.М.,

ассистент, кафедра управления проектами и программами,
Российский экономический университет имени Г.В. Плеханова, Москва, Россия
lusine.pm@gmail.com

Аннотация. В последнее время концепции бережливого строительства и информационного моделирования сооружений (BIM) стали основными инструментами решения ряда управленческих вопросов в строительстве. В статье предпринята попытка оценки возможности совместного использования обеих методов с целью повышения эффективности управления в строительстве. Результаты исследования показали, что большинство принципов, лежащих в основе концепции бережливого строительства, согласуются с принципами и методами информационного моделирования сооружений (восемь из них – полностью, четыре – частично, четыре – не согласуются). Авторы систематизировали преимущества совместного использования принципов обеих концепций в области управления проектами (качество проекта, риски, затраты, время, масштаб, человеческие ресурсы, коммуникации, снабжение и управление со стороны участников). Результаты исследования могут быть полезными для развития в России, как для дальнейших научных исследований, так и для практиков, управляющих проектами, а также для других специалистов строительных профессий.

Ключевые слова: BIM; принципы бережливого строительства; управление проектами; строительство; совместное использование; преимущество.

Whereas lean construction and Building Information Modeling as concepts and as practices have been under spotlight of academics, building companies, consultants, investors and IT specialists about last two decades, 'there has been hardly any interaction between these two camps', according to Lauri Koskela [3]. Regarding construction industry in Russia, we are now witnessing the boom of popularity of BIM both among government authorities and private companies. This has led to the start of legislative regulation in the sphere of BIM (as well as other

technologies of information modeling) application in construction. However, there has been any attention paid to lean construction concept in our country. Thus, it makes research on benefits of BIM and lean construction interaction even more relevant.

Initially the idea of possible synergic use of lean principles and BIM has developed in US less than ten years ago. There advocates of that idea studied in detail the interconnections between lean concept and BIM and also provided initial proofs. But, in our opinion, the problem is that,

as it was mentioned below, lean construction concept hasn't gained enough development in Russia. Moreover, talking about lean construction we imply the phase of construction itself, which is only one of the four phases of any construction project. However, up to now BIM has been used mostly for needs of design and pre-construction periods while delivering a construction project. Thus, the possible application of BIM and its benefits namely for construction and for construction projects in whole have not been studied fully yet.

Before going further, let us provide some initial definitions to better carry out this research. Starting with lean construction, it is worth mentioning that it is an innovative management concept and approach which was created by translating success of Toyota Production System to construction industry and whose core principles are:

- creating value for clients;
- removing (or at least reducing) waste (in processes, in information communication and literal construction waste);
- providing smooth flow of operations at construction site [5, p. 7].

Apparently, all these is supposed to cause less construction costs, higher revenue and business value. BIM being a tool for visual modeling of building's design [6, p. 45] and construction process can be applied to bring the principles of lean construction concept to life. Some researchers use even the term 'lean BIM' to highlight the concept of integrated use of BIM and lean construction principles which provides more synergic benefits than each concept itself.

As a building can be constructed virtually with the use of BIM it helps to integrate design and construction stages of any construction project more smoothly avoiding any mistakes and discrepancies that might occur. Thus, the results of planning become more accurate and concrete with the use of BIM. This happens because building designers can make any amount of design iterations (within the project budget) with the use of BIM to reach the optimal (according to the chosen criteria for the project considered) design features for the building.

Application of BIM in interests of lean construction also may lead to more ecologically friendly construction (less environmental waste) as even carbon footprint of the design can be in-

stantly analyzed through BIM. Thus, BIM asserts the least possible environmental impact from a building's existence, and makes it more operationally efficient for its owners throughout the building lifecycle. It also 'streamlines the building lifecycle processes to provide a safer and more productive environment for its occupants' [1, p. 102]. As a result, BIM can also be used for cost estimation, sustainability measurements, facility management, etc. [7].

What is more, BIM enables some lean processes such as collaborative planning and first run studies (especially for innovative and technologically complex projects). In addition to this, Martin Brown [2] points out one more significant benefit from combined use of BIM and lean principles — 'getting closer to the Honda expression of "everything we do goes into everything we do", while currently only 40–60% of what we do in construction goes into what we do, i.e. what we get paid for'.

Considering all benefits of combined Lean and BIM application and taking into account the methodology of project management we have systematized in more detail the opportunities of bringing to life principles of lean construction with the use of BIM (see Table 1):

As it can be seen from the table 1, 50% of lean principles can be fully realized with BIM, 25% — partly, and only another fourth of them — none. Furthermore, we aimed to make that more tailored for project managers so that they can definitely see the benefits of LeanBIM in every project management activities they do. Basing on the research results presented in table 1 above and using project management fundamentals covered in Project management body of knowledge [2, p. 61], we have widened and specified the benefits mentioned above for the existing project management fields (see figure 1):

So, following the principles of lean construction and using BIM provides project managers with the opportunity to:

- enhance team-wide collaboration,
- eliminate all types of waste,
- increase efficiencies of construction projects.

This inevitably should lead to overall improvement of business performance in construction industry. Below we have developed the consecutive linkage from lean construction principles to impressive BIM capabilities to effectively achieved project management goals and,

Table 1. Lean construction principles enabled with BIM use opportunities

Area	Principle of lean construction	Possible to do it with BIM	How it is done with BIM	Project stage	
Flow process	Reduce variability	+	evaluation of different alternatives and detailed planning of construction process through visualization	pre-construction and construction	
	Reduce cycle times	+	effective time and processes planning through visualization and evaluation of different alternatives	design, pre-construction and construction	
	Reduce batch sizes	+/-	rapid generation and evaluation of different alternatives and detailed planning of construction process through visualization		
	Increase flexibility	+	Rapid generation and evaluation of multiple design and construction alternatives (especially when facing uncertainties and risk situations)		
	Select an appropriate production control approach	+/-	Evaluation of different alternatives and detailed planning of construction process through visualization		
	Standardize	+	detailed planning and collaboration at design and construction stages through visualization, integration of information models at different project phases		
	Design the production system for flow and value	+/-	detailed planning of construction process through visualization which leads to higher value of buildings for clients		
	Use visual management	+	Visualization of processes, visual evaluation of alternative decisions		
	Institute continuous improvement				
	Value generation process	Ensure requirement flow-down	-		-
Ensure comprehensive requirements capture					
Focus on concept selection		+	visual evaluation of alternative concepts	design	
Problem-solving	Verify and validate	+	Rapid generation and evaluation of multiple design and construction alternatives (especially when facing uncertainties and risk situations)	design, pre-construction and construction	
	Consensus, consider all options	+	online/electronic object-based communication, visual evaluation	pre-construction and construction	
Developing partners	Go and see for yourself	+/-	See and check changes through multidimensional information model (instead of visiting the building site itself)	pre-construction and construction	
	Cultivate an extended network of partners	-	-	-	

project quality and scope management	<ul style="list-style-type: none"> • focusing on client value from the beginning up to the end of project
project time management	<ul style="list-style-type: none"> • lean and predictable sequencing
project cost management	<ul style="list-style-type: none"> • reducing unnecessary costs
project stakeholder management	<ul style="list-style-type: none"> • increasing value for clients
project risk management	<ul style="list-style-type: none"> • rapid visual valuation of changes and alternatives which enables rapid reaction to risk situations
project communications management	<ul style="list-style-type: none"> • improving information flow and communications between project partners and supply chain, project team members and managers, etc.
project human resources management	<ul style="list-style-type: none"> • standardised and controlled flow of project team members • less stress and smooth work of project team
project procurement management	<ul style="list-style-type: none"> • enabling just in time supply of materials • lean and predictable material sequencing

Figure 1. Specified benefits of LeanBIM for project management fields

finally, to higher business value for construction companies (see Figure 2):

Apparently all these lead us to the conclusion that integrated implementation of Lean and BIM in building companies, design firms, suppliers etc. should take place in nearest future to solve many accumulated problems the construction industry faces when it comes to project management. For example, according to statistics, project managers of high-end projects spend up to 60% of their time managing client changes and

giving instructions to other project participants rising from the need to implement these changes [5, p. 23]. And many other problems in project management can be listed here. But as in any cases of introducing changes there are always some obstacles. M. Younes points out these most tough challenges while implementing integrated Lean and BIM methodologies into project management in construction (see Figure 3) [8, p. 56]:

The figures above are taken from an international research, however, they seem quite the

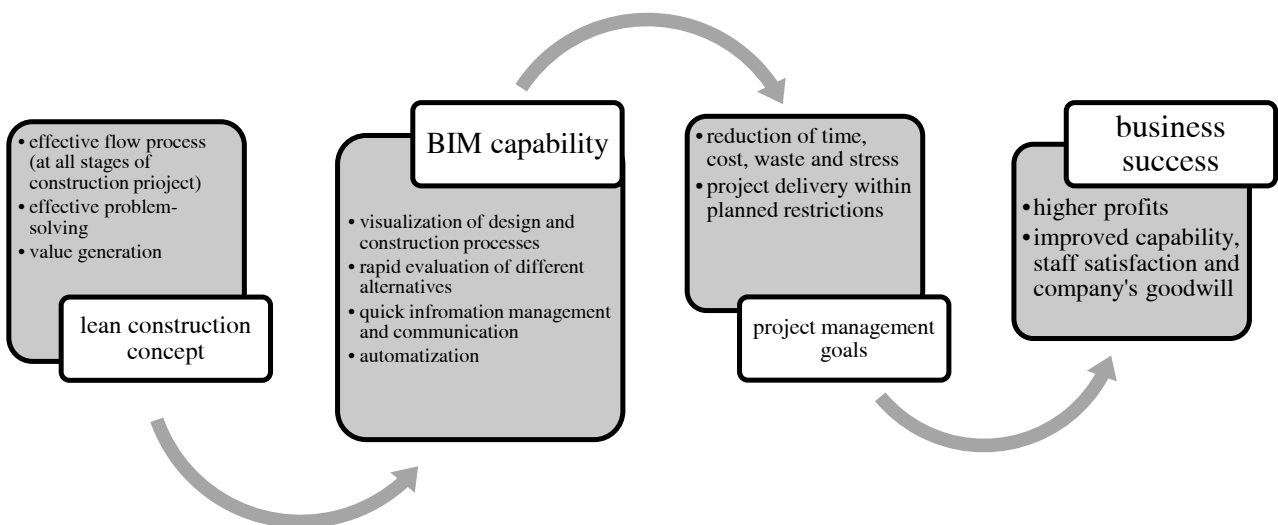


Figure 2. Consequent linkage 'Lean-BIM-project management-business success'

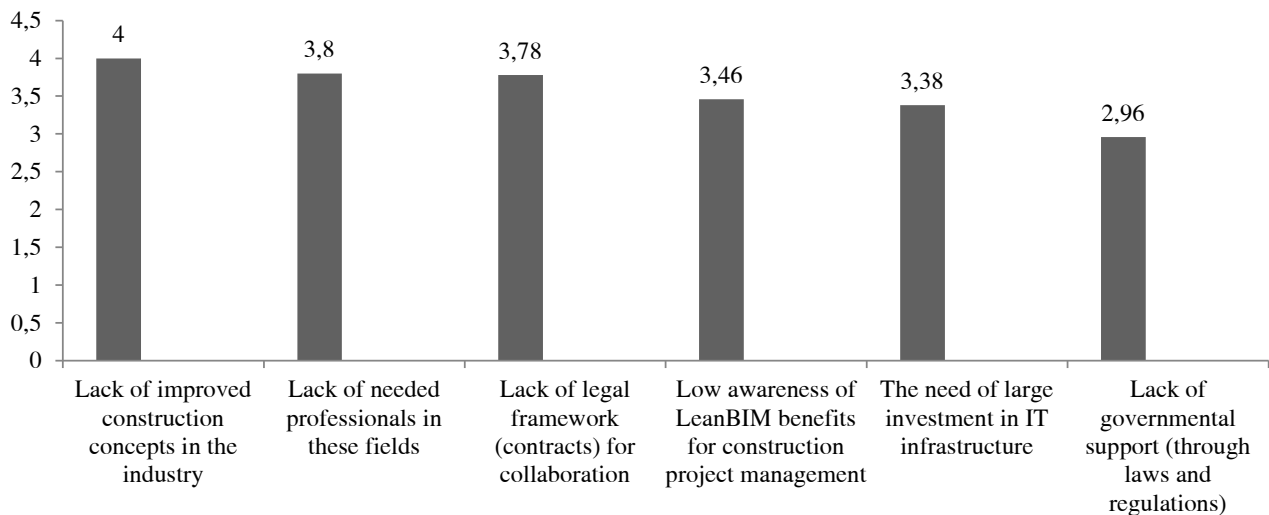


Figure 3. Gradation of challenges facing while implementing LeanBIM in construction project management

same for Russia. Actions to be taken for effective implementation of LeanBIM are also the same no matter which country we are talking about. To effectively implement both BIM and Lean, the following should be in place in any case:

- construction leadership at organization and at project level;
- contracting processes shaped around Lean and BIM requirements;
- people's (contractors, suppliers, stakeholders, other participants, etc.) collaboration mindset and real involvement in project short-term planning and improvement.

Finally, lean processes facilitate the implementation of BIM. Lean is characterized on one hand, by predictability and discipline, and on the other hand, by collaboration, learning and experimentation. All these features are very worthwhile in the implementation of BIM. Thus, the implementation of BIM should not be thought, presented or organized as a stand-alone initiative — all the efficiencies inherent in BIM can hardly be pressed out without embedding modeling within a lean construction environment. Conversely, in companies and projects with mature lean construction implementation, BIM should be positioned as another lean tool.

References

1. Arayici Y., Aouad G. (2010). Building information modelling (BIM) for construction lifecycle management. *Construction and Building: Design, Materials, and Techniques*, 2010, pp. 99–118.
2. Brown M. (2014). Lean BIM: Six reasons why construction needs to embrace BIM alongside Lean Thinking/ November, 2014. Available at: <http://ckegroup.org/thinkbimblog/lean-bim-six-reasons-why-construction-needs-to-embrace-bim-alongside-lean-thinking> (date of reference: 21.10.2016).
3. Koskela L. (2014). The implementation of Lean Construction and BIM should be integrated! *Infrastructure intelligence*. October 2014. Available at: <http://www.infrastructure-intelligence.com/article/oct-2014/implementation-lean-construction-and-bim-should-be-integrated> (date of reference: 19.10.2016).
4. Project management body of knowledge (PMBOK Guide). 5th edition: Project management institute, Inc., 2013, 586 p.
5. Sacks R. (2014). BIM and lean construction. Can BIM remove waste from construction processes? *Tekla European BIM Forum*, 2014, 66 p.
6. Sukhorukov A.I., Eroshkin S.Yu. (2016). Information and management: historical development of definitions. *Journal 'Competitiveness'*, 2016, no. 6 (137), pp. 43–47.
7. Younes M. (2014). LeanBIM: Unleash BIM Possibilities and Make Lean Construction Even Leaner. August, 2014. Available at: <http://leanconstructionblog.com/LeanBIM-Unleash-BIM-possibilities.html> (date of reference: 24.10.2016).
8. Younes M. (2015). Reshaping Construction Management for Sustainability and Resource Efficiency. Implementation of LeanBIM Concept in Construction, 97 p.