Towards Sustainable Buildings Production Through the Lens of Lean Construction Perspectives

Evelyn L. A. Allu, Central University of Technology, South Africa
Fidelis A. Emuze, Central University of Technology, South Africa

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Abstract
The study proposes the application of the principles of lean construction to the processes that would lead to the production sustainable buildings. This is aimed at promoting sustainability in the built environment, because buildings form the greater per cent of the built environment. Sustainable buildings are the products of sustainable processes of design and construction, while lean construction manages and adds value to the processes of construction from the conceptions to the delivery of the construction deliverables – buildings. The study's discourse presents the concepts of lean applications and the novelty it provides to the construction of buildings sustainably. This theoretical discourse suggests that lean applications to construction activities has threefold positive impact on the construction sector. Firstly, it guides the design conception of buildings. Secondly, it controls the deliverable processes of their construction and thirdly, it improves and allows for the production of sustainable buildings as against those from the conventional construction processes. These in the overall ensure the production of sustainable buildings and promote environmental sustainability. Furthermore, the study recommends amongst others a deliberate reorientation of the construction sector practitioners and encourages the installations of mechanisms that would ensure the implementation and application of lean principles into the processes leading to the production of sustainable buildings.

Keywords: buildings, built environment, lean principles, construction, sustainability

Introduction

The construction sector forms a significant part of the built environment and construction projects are ever increasing globally. According to Newswire Report (2016) the industry has a forecast growth rate of 5.5% and its major drivers are the continuous growth rate of urbanization and population (Govindan et al., 2016). As much as this sector has the largest market (Newswire Report, 2016; Market Research Hub, 2017), is also a huge employer of labour and drives the economy of many countries (Wibowo, 2012; Allu, 2014). This is because the demand for housing and other infrastructures is high (Govindan et al., 2016). The sector is also hugely responsible for environmental waste and pollutions (Atkinson 2008; Dixon; 2010; Wenger, 2012; WRI, 2016). So much so that many agencies, government (Sarhan and Fox, 2013) and researchers (Govindan et al., 2016; Jamil and Fathi, 2016) expressed concern for new construction project to comply with processes that are sustainable in order to minimise waste and promote environmental sustainability (Jamil and Fathi, 2016). Additionally, there is also the global challenge for curb poor construction performance and delivery (Sawhney et al., 2014). These challenges propelled the construction sector to look for possible strategies that would address both the construction waste and promote environmental sustainability.

In order to address these challenges for the construction sector, the lean perspectives to construction has been adopted in some countries. In the construction arena the lean perspective is seen processes that improves production quality and add value to project delivery (Forbes and Ahmed, 2011; Banawi, 2013). Additionally, LC also promotes sustainability within the built environment sector with consciousness for the future (Banawi, 2013; Bawani and Bilec, 2014; Ogunbiyi et al., 2014).

This study's focus is therefore, to presents the theoretical underpins of the applications of lean construction, in order to further raise the awareness and knowledge of construction professionals. This is aimed at repositioning and reorienting the construction practitioners towards the applicable options of engaging with lean approach to construction practices. The applications are discussed as the potentials of LC in relation to firstly; the pre and design phase, secondly, during the construction processes and lastly, how the two phases ensure that the construction projects or buildings are improved upon sustainably.

Lean Construction Potentials

The term 'Lean construction' has its origin from the International Group for Lean Construction in 1993 (Gleeson et al., 2007). According to Biton and Howell (2013) Lean Construction (LC) has been around for a long enough period to move beyond theory to actions. Yet, its applications are still new to many countries (Sarhan et al., 2017). LC also has been acknowledged to be a supplementary process from the traditional construction management, that reduces waste, manage and improves the processes of design and construction productivity sustainably (Abdelhamid, 2007; Azziz and Hafez, 2013, Issa, 2013). The lean thinking and its principles drive the lean applications for any production process to be effective. These principles are; customer based value identification, generation of value streams through delivery value, removal of waste through improved processes, creation of system-pull-production and pursuits for perfections in all processes (Kumar et al., 2013). Thus, enhancing the

application of lean principles into the processes of design and construction becomes a continuous flows at all levels or phases of production. It is therefore, necessary to understand how the lean principles in construction can impact positively on the design and construction productivity sustainably, through the application of lean principles into design and construction.

Lean thinking (Perspectives) in Design and Construction

The act of constructing a building starts with the design phase and consequently, when the design thinking is well thought-out then the construction process would follow suit. Lean Construction also starts with lean thinking towards designing and the planning of cost effective the production processes (Pinch, 2005; Aziz and Hafez, 2013). As such, optimising the design processes with the principles of lean would subsequently be expected to also gear up processes of production of buildings through construction.

Most of the environmental waste and depilation of raw materials from the natural environment is ascribed to the activities of the construction sector. Researcher have also opined that the production activities in construction of buildings are still; wasteful, poor performance and time consuming (Issa, 2013). Whilst other researchers argued that this situation is likely because the adoption of lean thinking to construction is still transitional (Viana et al., 2012; Sarhan and Fox, 2012), cultural barriers and because of poor perceptions and implementation of the lean perspectives by practitioners (Biton and Howell, 2013; Kannan et al., 2016). In furtherance to these discourse, the need for the integration of lean principles to design and construction are always being sought. Researchers have suggested that the use of necessary tools are required to support the implementation of lean construction for the design and construction (Sarhan et al., 2017). These tools are collated from the different studies and are presented in Table 1 in relation to design and construction phases.

Table 1. Tools that support lean construction implementation
Source: Author's arrangement, 2017

s/n	**Design Phase**	**Construction Phase**
1	Understanding client's brief	Understanding clients value for project deliverables
2	Computer aided design	Computerised systems planning
3	Target value design	Target planned schedules
4	Sustainable approaches to design process	Preferences for prefabricated materials to reduce waste
5	Environmental consciousness to design specifications	Environmental consciousness to construction activities
	Value adding design features	Value adding activity schedules
6	Continuous refresher and improvement development and training	
7	Daily meetings and appraisals	
8	Preventive and routine maintenance options	
9	Concurrent engineering options	
10	Health and safety measures	

As discussed, the prerequisite for engaging with lean construction is lean thinking. However, it goes beyond the reorientation of practitioners to 'think lean for sustainability' but to also adopt and use the necessary available resource and tools in this regards in order to produce sustainable buildings. According to the study conducted by Sarhan et al. (2017) the use and implementation of lean construction is the tool required for the construction industry to improve its; productivity, quality, customer satisfaction, relationships and to minimise waste. Thus validating an earlier study by Arayici et al. (2011) who opined that, the overall engagement practitioners with lean approaches to design and construction led to improved productivity and capacity building amongst its practitioners.

Conclusion

The construction industry has been continuously faced with poor performance, environmental waste management challenges, in the face of global concern for environmental sustainability. The ability to re-orientate the built environmental practitioners to; think lean, adopt and apply lean techniques and principles would promote effective construction productivity. Secondly, the processes of design and construction are guided to have a systematic sequential flow in its deliverable purpose. Thirdly, buildings produced from the processes of lean construction are going to be sustainable buildings. Finally, since the operations of lean construction are sustainable, in the overall, the adaptations and implementation of lean construction promotes environmental sustainability. Further research is proposed to develop a

framework that integrates sustainable lean construction processes into construction practices to validate the theoretical methodologies.

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