

A THEORETICAL REVIEW OF LEAN IMPLEMENTATION WITHIN CONSTRUCTION SMEs

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Abstract

Small and Medium Enterprises (SMEs) are considered the backbone of many economies. SMEs constitute over ninety percent of global enterprises and account for about sixty percent of employment. However, SMEs still suffer from many problems such as low product quality and working efficiency, budget overruns, significant construction waste, etc. Lean construction has increasingly been implemented as a potential solution for organizations to deal with waste of all types. Limited studies exist on Lean implementation in Construction SMEs. This paper sought to suggest Lean tools which can be implemented within the Construction SME set-up. A systematic review of empirical and theoretical studies published from Research Gate, International Group of Lean Construction conference (IGLC), Science Direct (Elsevier), Emerald Insight, Taylor and Francis, Google Scholar and other internet sources were considered in this study. This paper was based on four hypotheses, which are related to the construction SMEs capacity to implement lean as efficiently as large enterprises. The review found that Lean principles could be applicable in Construction SMEs, but has to be contextualized within their peculiar characteristics such as their Size, Financial Capabilities, Organisational Culture and Human Resource Capacities. The paper concludes by suggesting Lean tools such as 5S, A3's, 5 Why's etc., that require less monetary investments to be implemented by construction SMEs. A change of mind-set is needed for Lean implementation as there is still a lower rate of adoption amongst SMEs.

Keywords: SMEs, Lean Construction, Process Improvement, Value, Innovation.

Introduction

The performance of the construction industry in Ghana is poor, and faces several problems ranging from contract administration, through complex and lengthy payment procedures, delayed payments to that of project execution (Westring, 1997; Crown Agents, 1998; Anvuur and Kumaraswamy, 2006). The Ghanaian Construction industry is dominated by large number of small-and medium-sized firms (SMEs) and are characterised by high attrition rates. They are the least organised with their performance usually below expectation. In essence, there is not much difference between the problems militating against the Ghanaian construction industry, regarding project execution and performance, and those of other developing countries. The main difference, however, is that Ghana is yet to take the necessary steps to address the problems (Gyadu-Asiedu, 2009).

Small and medium-sized enterprises (SMEs) are one of the most significant forces for economic growth. SMEs are recognized all over the world as vital in the stimulation of innovation, economic growth, job opportunities and poverty reduction and support large-scale enterprises. SMEs account for approximately 90% of businesses and more than 50% of employment worldwide. In developing countries, SMEs account for 45% of formal

employment (Bauchet and Morduch, 2013). SMEs are also believed to contribute about 70% to Ghana's GDP and account for about 92% of businesses in Ghana (Ackah and Vuvor, 2011). Therefore, the contribution of this sector to the economy of Ghana cannot be overemphasized.

Notwithstanding these attributions, SME building contractors still suffer from many fundamental problems such as low product quality, low working efficiency, projects finishing over budget, huge construction waste, and others. Lean construction is a potential solution to the many problems faced within the industry and results in exceptional performance improvements (Bhamu and Sangwan, 2014). Yet there is still a lower rate of Lean adoption by construction SMEs both in Ghana and other countries. This issue has always been explained by the fact that SMEs lack the capacity to implement such management philosophy. In some studies conducted earlier, it was revealed that SMEs do not have the capacity to implement Lean construction (Ayarkwa et al., 2012; Shang, 2013). Construction SMEs and the industry as a whole has been criticized by many with regards to its adversarial nature, the take up of new technologies and processes and issues associated with organisational management (Miller et al., 2002). Construction SMEs form the largest group, and their performances impact greatly on the performance of the whole industry (Gyadu-Asiedu, 2009). Therefore, any improvements efforts in SMEs will impact greatly on the performance of the industry as a whole.

Any method that seeks to make an enterprise Lean always reduces waste and maximizes value in the company; enhancing core resources and establishing a corporate culture dedicated to identifying and continuously promoting customer satisfaction. The principles in making an enterprise Lean can be classified as identifying value, eliminating waste, and generating smooth flow (Azharul Karim, 2013).

It appears, however, that there is a significantly lower rate of adoption of Lean principles in SMEs compared to Large Enterprises (LEs) (Shah

and Ward, 2003) and that many SMEs are still unfamiliar with Lean implementation (Achanga et al., 2006).

Research Methodology

The paper was developed based on a review of empirical and theoretical studies already published. Past research on Lean construction and SMEs were obtained primarily from research databases including Research Gate, IGLC Science Direct (Elsevier), Emerald Insight, Taylor and Francis, Google Scholar and other internet sources. The initial descriptors used for the search were "Lean construction tools," "construction SMEs," "Lean and construction SMEs. The initial descriptors were used to search the databases. A total of 75 articles were reviewed for the research. This paper is based on four hypotheses, which are related to the construction SMEs capacity to implement Lean as efficiently as large enterprises. The hypotheses are: Does the size of the firm matter in Lean adoption and implementation?; Can SMEs apply the Lean package partially in order to reap its benefits?; Can SMEs still benefit from Lean considering their organizational structure, culture, financial and human resource capacities? and is the organisational culture of Ghanaian construction SMEs supportive of Lean construction? The paper sought to answer these questions and continues to suggest lean tools that can be implemented by the construction SMEs in Ghana.

Need for Lean Implementation in Construction SMEs

There is the need for the Construction SMEs to be more aware of Lean and be able to inspire their employees, clients and partners in order to attain greater joint performance (Ofori and Toor, 2012). This, the authors believe can be achieved through the implementation of Lean construction principles in the Ghanaian construction SMEs. Studies

conducted within the Ghanaian construction industry suggest a low level of familiarity and application of Lean construction among practitioners within the industry (Ayarkwa et al., 2012; Ankomah et al., 2015). There have been a number of reviews of the Lean literature. For example, Hines et al. (2004) reviewed the evolution of Lean, Holweg (2007) looked at the genealogy of Lean production, Moyano-Fuentes and Sacristan-Diaz (2012) developed an overview framework of Lean, and most recently Shang (2013), in his PhD thesis proposed an implementation framework for large Chinese construction companies. These reviews have largely focused on Lean in general or larger enterprises and thus there is a gap in reviewing the literature on Lean that is pertinent to SMEs.

Rose et al. (2011) pointed out that there is currently no standard measure for Lean implementation that SMEs can adopt, as different researchers take varying perspectives, but they do show that SMEs should go for the least costly practices, such as 5s, Visual Management (VM), etc. SMEs have challenges with their processes or production thus making the implementation of Lean in construction worth exploring.

Lean Applicability within Construction SMEs

This paper is based on four hypotheses, which are related to the construction SMEs capacity to implement Lean as efficiently as large enterprises.

Does the Size of the Firm Matter in Lean Adoption and Implementation?

There is still considerable interest as to whether there is a difference in the applicability of Lean between Large Enterprises (LE) and SMEs (e.g. Rose et al., 2013). The size of a firm continues to be discussed whether it is a critical factor in Lean implementation. Many authors have indicated that Lean is more suitable for large industries

than SMEs (e.g. Shah and Ward 2003; Achanga et al., 2006; Wong et al., 2009; Powell and Gran, 2012). The researchers argue that there is difficulty for SMEs to cope with Lean due to their lack of required resources and capabilities. However, other researchers disagree (e.g. Ahire and Golhar, 1996; Ghobadian and Gallea, 1997; Karlsson and Åhlström, 1997), stating that size does not affect a firm's ability to implement Lean, and that SMEs can implement these systems as effectively as large organisations. This is in line with Rose et al. (2011) who suggested that SMEs can implement Lean but should go in for the least costly practices. It is the preliminary proposition of the authors that the size of the firm does not really matter. Small firms by virtue of their size can implement some Lean tools to their own benefit but need to go in for tools that requires less investment.

Can SMEs Apply the Lean Package Partially in Order to Reap its Benefits?

Although, some researchers (e.g. Liker, 2004; Anand and Kodali, 2009) have suggested that Lean practices should be implemented as a full package, Golicic and Medland (2007) argued otherwise. The researchers believed that Lean can be applied partially. The application of some Lean tools will lead to gradual performance improvement of SMEs and which can then lead to more advanced practices (Rose et al., 2011). Furthermore, according to Oviatt and McDougall (1994), SMEs have a better chance of adapting to change compared to large companies, as they are less bureaucratic than large firms. Additionally, they can internalise and crystallise the information across entire departments more efficiently than large corporations.

Can SMEs Still Benefit from Lean Considering their Organizational Structure, Culture, Financial and Human Resource Capacities?

At the financial level, most researchers posited that

SMEs lack the funding (Golhar et al. 1990; Ormsby et al., 1994; Lee 1996; Dowlatshahi and Taham, 2009; Thomas et al., 2009; Mazanai, 2012) and infrastructure/facilities (Boughton and Arokiam, 2000; Panizzolo et al., 2012) needed to implement Lean. The on-going implementation of the full version of Lean can require substantial sums of investment before benefits are realised and SMEs may be more restricted in this regard in terms of available financial resources or the ability to invest the up-front in the time needed to support training and knowledge development (see e.g. Mazanai, 2012). SMEs can implement some of the tools such as the last planner, 5S etc., to enhance their performance and productivity. This, the SMEs can do without having to invest huge sums of monies. As the SMEs grow they can implement other tools which require substantial investments such as Building Information management (BIM).

Lee and Oakes (1995) showed that Lean is applicable to SMEs as they have the ability to build the required culture in terms of leadership and work force involvement much more easily than large companies, since they have relatively little functional differentiation, which makes the management very close to workers. Antony and Kumar (2005) shared the same view, suggesting that the organisational culture in SMEs is full of energy and that they are willing to “learn and change” rather than “control”; the SME culture is friendlier, since relationships between workers and top management are loose and informal.

Is the organisational culture within Ghanaian construction SMEs supportive of lean Construction?

The construction industry differs culturally from one country to another and therefore practices and procedures which are well suited to the culture of one country may not be suitable in other countries (Kheni, 2008). Evidence from literature suggests that an organisation cannot succeed in Lean unless it has a healthy culture. In the UK, only 10% of firms succeed in their Lean implementation efforts. The reason behind the low success rate

is culture and management (Taleghani, 2010). Culture is a vital factor for a successful Lean implementation (Al-Swidi and Mahmood, 2011). Dahlgaard and Dahlgaard-Park (2006) argued that appropriate culture cannot be compromised if a company wants to adopt lean successfully. A discussion on organizational culture is appropriate as Lean initiatives are normally undertaken at the organization level, where changes occur away from the traditional management approaches to construction (Shang, 2013). According to Atuahene (2016), small firms in Ghana have a dominant hierarchy culture focused on the internal structures. The relationship between contractors and suppliers within the industry is also short-term and only based on the needs of current projects (Ankomah et al., 2015). Lean construction requires a culture of employee empowerment, teamwork, and enhanced relationship with employees and suppliers (Womack et al., 1990). Companies that have successfully implemented Lean have argued that it would not have been possible without a sustained employee and supplier engagement and support at all levels of the organization (Korb, 2016). Hierarchical structure, along with a top-down leadership style, is one of the many cultural barriers that cause lean initiatives to fail (Shang, 2013). There will be a need for culture change in the Ghanaian construction industry to accommodate Lean initiatives.

Lean Practices

Table 1 identifies Lean practices applicable to construction, with a brief description of the tools and references based on the literature. The classification was mostly based on analysing the papers published in IGLC proceedings, although other studies published elsewhere were also consulted.

Table 1. Identified Lean Practices Applicable to Construction, Description of the Tools and References

Lean Tools	Brief description	References
Last Planner System	The Last Planner™ System (LPST™) provides a regimented process of achieving reliable workflow on simple and complex construction projects. This system was created in order to improve the predictability and reliability of construction production.	Toledo et al. (2016), Ballard and Howell (1994), Habchi et al. (2016), Porwal et al. (2012), Salem et al. (2005)
Increased Visualisation	It is about communicating key information effectively to the workforce through posting various signs and labels around the construction site. This includes signs related to safety, schedule, and quality.	Salem et al. (2005), Moser and Dos Santos (2003), AlNimr and Mohammed (2010)
Daily Huddle Meetings	Daily huddles are for communication, not only for managers to talk to employees, but also for employees to express themselves and learn from each other.	Salem et al., (2005)
5S Process	5S is a basic method for clean-up and organisation of the workplace.	Leino et al. (2014), Hafey (2010), Tezel et al. (2016), Berrior et al. (2015)
5 Why's	It works by asking once why an effect happened, and to the response of that question, ask again, why it happened. Same procedure is repeated until asking five times why it happened and by the end of the process, the answer is the root cause.	Fuenzalida et al. (2016), Kemmer et al. (2006)
Concurrent Engineering	A simultaneous engineering that attempts to optimise the design of a project and its construction process by the integration of design, fabrication, construction and erection activities.	Kamara (2003), Knotten et al. (2014), Ballard and Koskella (1998)
Choosing by Advantages (CBA)	CBA is a value-based Multi-Criteria Decision-Analysis system that supports sound decision-making based on the comparisons among the advantages of alternatives.	Suhr (1999), Arroyo et al. (2012a), Arroyo et al. (2013); Mossman (2012); Parrish and Tommelein (2009), Kpamma et al. (2014)
Building Information Modelling (BIM)	A virtual process that encompasses all aspects, disciplines, and systems of a facility within a single, virtual model. Some new concepts and BIM applications have been developed for different purposes in the construction industry, such as 4D, 5D, 6D and 7D dimensions	Lee (2008), Harris and Alves (2016), Dave et al. (2015), Abou-Ibrahim and Hamzeh (2016)
Kaizen	Kaizen is a Japanese word for improvement. This Lean construction tool involves looking at some task in the field and finding out how to do it better, more efficiently, safer and quicker.	Liker and Meier (2006), Rossiti et al. (2016), Pasquire and Connolly (2002)

Poka-Yoke	In building a culture of stopping to fix problems, poka-yoke is one of the Lean tools that help the employees to detect the defects and halt the process. It is synonymous with fail safe for quality and safety.	Shang (2013), Tommelein (2008)
A3 Report	An A3 is an orderly document that aids thinking. A3 reports are so named because they fit on one side of an A3 size paper. The A3 report is a way of representing an action course, in which goals, methodology, agents involved and others are included. The document is for problem solving, proposing action or project status reporting.	Fuenzalida et al. (2016), Gupta et al. (2009), Rybkowski et al. (2016), Koskela (2015)
The Ishikawa diagram	The Ishikawa diagram is a representation of a cause-effect analysis that is carried out for any type of result.	Fuenzalida et al. (2016)
Location Based Management System (LBMS)	The Location Based Management System (LBMS) provides a much needed spatial element to planning	Kenley and Seppänen (2010), Dave et al. (2016), Frandson et al. (2015)
Andon	A visual control tool which shows the operation status and signalize the occurrence of abnormalities.	Biotto et al. (2014), Kemmer et al. (2006)
Heijunka	Leveling the work flow of a production system and balancing or distributing load and capacity	Alves et al. (2009), Barbosa et al. (2013)
Value Stream Mapping	Systemic view of the production process (of the value flow), identification of real problems and wastes and proposition of improvements.	Murguia et al. (2016), Covarrubias et al. (2016)
Material Kanban Cards	It is used as a material process flow technique for the pull replenishment logic system.	Arbulu et al. (2003), Jang and Kim (2007)
Six Minute Exchange Die (SMED)	SMED practices in project management can be seen as a method for fast tracking the project schedule.	Antunes et al. (2016), Hofacker and Gebbauer (2010)
Action Learning	The core idea behind Action Learning is to create small, mutually supportive groups (known as SETs) of people who band together to solve real problems or difficulties which are not solved in current best practice.	Davey et al. (2000), Hirota and Fomoso (2001)

Based on the Lean construction tools identified within the literature in Table 1, the authors classified these tools into three groups, namely;

- Tools that require less monetary investment to implement.
- Tools that can be fully implemented by construction SMEs.
- Tools that can be partially implemented by SMEs.

The categorisation has been done for purposes of suggesting Lean construction tools for use by SMEs based on their peculiar characteristics. Table 2 is based on the categorization as indicated above.

Table 2. Lean Tools

Lean Tools	Criteria		
	A	B	C
Last Planner System	×	×	
Increased Visualisation	×	×	
Daily Huddle Meetings	×	×	
First Run Studies	×	×	
5s Process	×	×	
5 Why's	×	×	
Concurrent Engineering	×	×	
Choosing by Advantages (CBA)	×	×	
Building Information Modelling (BIM)			×
Kaizen	×	×	
Poka-Yoke	×	×	
A3 Report	×	×	
The Ishikawa diagram	×	×	
Location Based Management System (LBMS)	×	×	
Andon	×	×	
Heijunka	×	×	
Value Stream Mapping (VSM)	×	×	
Material Kanban Cards	×	×	
Six Minute Exchange Die (SMED)	×	×	
Action Learning	×	×	

Researchers such as (Rose et al, 2011; Salem et al 2005) have affirmed tools such as 5S, Kanban SMED, Kaizen, Increased visualization, Last Planner, Daily Huddle Meetings, First Run Studies, Poka-Yoke, Andon as tools that are least costly and can be implemented by SMEs. A review of the literature on the other Lean construction tools (5 Why's, Concurrent Engineering, Choosing By

Advantages, A3 report, Ishikawa Diagram, LBMS, Heijunka, VSM, Action Learning) shows these are not capital intensive and therefore within the reach of SMEs. The authors will subsequently validate these other Lean construction tools. A major issue that acts as a challenge to SMEs is finance. Considering the poverty levels in Ghana, the authors suggest the Lean tools that require less monetary investments to be implemented by construction SMEs as can be seen in Table 2. These the SMEs can implement without having to invest so much and as they grow they can implement tools such as BIM which requires some investments in software and hardware. Construction SMEs can also implement soft aspects of Lean construction such as employee involvement, teamwork, reward and recognition, communication etc, which will not require huge monetary investment. In the same vein SMEs can implement some aspects of BIM such as 3D, which does not require substantial investments. SMEs can still benefit from fragmented or isolated use of Lean tools, but the benefits will not come close to the implementation of the full system (Liker, 2004). Since SMEs lack capacity to fully adopt Lean construction, there is a clear need to build on their capacity to fully adopt Lean construction philosophy.

Strategies: Adopting Lean Practices within Construction SMEs in Ghana

A change in mind-set is required before embarking on the implementation. This is because a fundamental part of any Lean strategy begins from a change of mind-set and of organizational culture (Liker and Meier, 2006). Top management must intervene and require people to behave differently, starting with changing their conventional mind-set. As this process is repeated, a different set of beliefs and values - a new organizational culture will eventually evolve. This however requires a long-term endeavour and commitment to continuous improvement.

Professional bodies such as the Ghana Institute of Architects (GIA), the Ghana Institution of Surveyors (GhIS) and the Ghana Institution of Engineers (GhIE) should expose their members to the concept of Lean thinking through their continuing professional development programmes. There could also be collaboration with leading institutional proponents of Lean construction like the Lean Construction Institute (LCI), to offer special training for Ghanaian contractors on the strategies of applying the Lean thinking concept within the industry. Furthermore, there should be a deliberate government policy to implement Lean especially within public sector construction works. There is the need for research and teaching to be strengthened in the academic and professional training of students pursuing construction related disciplines.

Conclusions

The global economy is changing and becoming much more competitive. The benefits of implementing Lean are substantial while the cost of not being able to meet project goals may be very significant. The primary objective of this paper was to propose Lean construction tools that can be implemented within construction SMEs set-up. This is against the backdrop of SMEs lack of the needed resources to implement Lean construction. Through a review of literature, this paper has proposed Lean construction tools that can be implemented within the construction SMEs set-up. The study found that SMEs can implement some soft and hard aspects of Lean such as the last planner, 5S, teamwork etc., which will not require having to invest huge sums of monies. This is an important finding as some authors have argued that SMEs do not have the capacity to implement Lean construction. This is a preliminary work on an ongoing PhD which aims to develop a Lean implementation framework to enhance the performance of Construction SMEs. The findings in this study will be validated through a nationwide survey, case studies and interviews in Ghana.

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