# A THEORETICAL REVIEW OF LEAN IMPLEMENTATION WITHIN CONSTRUCTION SMEs

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## ABSTRACT

Small- and medium-sized enterprises (SMEs) are considered the backbone of many economies. SMEs constitute over 90% of global enterprises and account for about 60% of employment. However, SMEs still suffer from many problems, such as low product quality and working efficiency, budget overruns, and substantial construction waste. Lean construction has increasingly been implemented as a potential solution for organisations to deal with waste of all types. The aim of this article is to suggest lean tools that can be implemented within the construction SME set-up. A systematic review of empirical and theoretical studies obtained from ResearchGate, International Group for Lean Construction (IGLC) conference proceedings, ScienceDirect (Elsevier), Emerald Insight, Taylor & Francis Group, Google Scholar, and other Internet sources was conducted in this study. This paper was based on four hypotheses, which are related to construction SMEs' capacity to implement lean as efficiently as large enterprises do. The study found that lean was applicable in construction SMEs, but that it has to be contextualised within the peculiar characteristics of the SME, such as its size, financial capabilities, organisational culture, and human resource capacity. The paper concluded by recommending lean tools such as 5S, A3 problem solving, and 5 Whys, which require less monetary investment to be implemented by construction SMEs. A change of mindset is needed for lean implementation, as there is still a low rate of lean adoption among SMEs.

**Keywords:** SMEs, lean construction, process improvement, value, innovation

## INTRODUCTION

The performance of the construction industry in Ghana is poor, and it experiences several problems, ranging from contract administration difficulties to complex and lengthy payment procedures, from delayed payments to project execution challenges

(Anvuur et al., 2006). The construction industry in Ghana is dominated by small- and medium-sized enterprises (SMEs), which are characterised by high attrition rates. These are the least organised of enterprises, and their performance is usually below expectations. In essence, there is not much difference between the problems militating against the construction industry in Ghana regarding project execution and performance and the problems experienced in the construction industry in 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 recognised worldwide as vital in the stimulation of innovation, economic growth, job opportunities, and poverty reduction, and they 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 to 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 overemphasised.

Notwithstanding these contributions, SMEs still suffer from many fundamental problems, such as low product quality, low working efficiency and projects being completed over budget, and huge construction waste, among other things. Lean construction is a potential solution to the many problems faced within the industry, and it results in exceptional performance improvement (Bhamu and Sangwan, 2014). Yet there is still a low rate of lean adoption by construction SMEs, both in Ghana and in other countries. This problem has always been attributed to the fact that SMEs lack the capacity to implement such a management philosophy. In some earlier studies, it was revealed that SMEs do not have the capacity to implement lean construction (Shang, 2013; Ayarkwa et al., 2012). Construction SMEs, and the industry as a whole, have been criticised by many for limited collaborative working ethos, their slow uptake of new technologies and processes, and issues associated with organisational management (Miller et al., 2002). Considering the investment levels of the construction industry, and the development needs of most developing countries, attention to these matters is long overdue. Construction SMEs constitute the largest group in the construction industry, and their performance impacts greatly on the performance of the industry as a whole (Gyadu-Asiedu, 2009). Therefore, any improvement efforts to 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 maximises value in the company, enhancing core resources and establishing a corporate culture dedicated to identifying and continuously promoting customer satisfaction (Arroyo and Gonzalez, 2016). The principles in making an enterprise lean can be categorised as identifying value, eliminating waste, and generating smooth flow (Azharul and Arif-Uz-Zaman, 2013). It appears, however, that there is a significantly lower rate of adoption of lean principles in SMEs than in large enterprises (LEs) (Shah and Ward, 2003), and that many SMEs are still unfamiliar with lean implementation (Achanga et al., 2006).

## RESEARCH METHODOLOGY

The article was developed based on a review of empirical and theoretical studies already published. Past research on lean construction and SMEs was obtained primarily from research databases, including ResearchGate, IGLC conference proceedings, ScienceDirect (Elsevier), Emerald Insight, Taylor & Francis Group, Google Scholar, and other Internet sources. The initial descriptors used for the search were "lean construction tools", "construction SMEs", and "lean and construction SMEs". The initial descriptors were used to search the databases. A total of 75 articles were reviewed for the research. This work is based on four research questions, which are related to construction SMEs' capacity to implement lean as efficiently as large enterprises do. The questionss are: "Does the size of the firm matter in lean adoption and implementation?"; "Can SMEs benefit from lean if they apply the lean package only partially?"; "Can SMEs benefit from lean, considering their organisational structure and culture, and their financial and human resource capacities?"; and "Is the organisational culture of construction SMEs in Ghana supportive of lean construction?" The article seeks to answer these questions, and it goes on to recommend lean tools that can be implemented by construction SMEs in Ghana.

## THE NEED FOR LEAN IMPLEMENTATION IN CONSTRUCTION SMEs

Construction is one of the world's major industries, and it is normally recognised as having high levels of waste (Bølviken and Koskela, 2016). There is a need for construction SMEs to be aware of lean and to be able to motivate their employees, clients, and partners to attain greater joint performance (Ofori and Toor, 2012).

This, the authors believe, can be achieved through implementation of lean construction principles in construction SMEs in Ghana. There have been a number of reviews of literature on lean. For example, Moyano-Fuentes and Sacristán-Díaz (2012) developed a general framework for lean, and, most recently, Shang (2013), in his PhD thesis, proposed a lean implementation framework for large construction companies in China. These reviews have largely focused on lean in general, or they have focused on larger enterprises, neglecting smaller ones. There is thus a gap in the literature on lean that is pertinent to SMEs. Given the nature of the contingency management approach, it follows, then, that a management philosophy such as lean construction is contingent upon the characteristics of each unique organisation. The fact that such management practices have worked well for large enterprises does not necessarily mean that they will work well in SMEs. It is more important to adjust where necessary to better suit the peculiar characteristics of SMEs. Studies conducted within the construction industry in Ghana suggest a low level of familiarity and application of lean construction among practitioners within the industry (Ankomah et al., 2015; Ayarkwa et al., 2012).

Rose et al. (2011) pointed out that there is currently no standard measure for lean implementation that SMEs can adopt. Although different researchers have different perspectives on the issue, they stress that SMEs should opt for the least costly practices, such as 5S, visual management (VM), etc. SMEs face challenges in their processes of production, and this makes the implementation of lean in construction

worth exploring.

## LEAN APPLICABILITY WITHIN CONSTRUCTION SMEs

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

### *Does 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 (LEs) and SMEs (Rose et al., 2013). It is the subject of continued debate whether the size of a firm is a critical factor in lean implementation. Many authors have suggested that lean is more suitable for large enterprises than for SMEs (e.g. Shah and Ward, 2003; Achanga et al., 2006). The researchers argue that implementation of lean by SMEs is a challenge, due to their lack of required resources and capabilities. However, other researchers disagree, asserting that size does not affect a firm's ability to implement lean, and that SMEs can implement these systems as effectively as large organisations do (Rose et al., 2011). They go on to assert that SMEs can implement lean, but that they should opt for the least costly practices. The authors' provisional proposition is that the size of the firm does not really matter. Small firms, by virtue of their size, can implement some lean tools for their own benefit, but they need to opt for tools that require less investment.

### *Can SMEs benefit from lean if they apply the lean package only partially?*

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) have argued otherwise. The researchers believe that lean can be applied partially. Application of some lean tools will lead to gradual performance improvements in SMEs, which can then lead to more advanced practices (Rose et al., 2011).

### *Can SMEs benefit from lean, considering their organisational structure and culture, and their financial and human resource capacities?*

At the financial level, SMEs lack the funding (Mazanai, 2012) and infrastructure/facilities (Panizzolo et al., 2012) needed to implement lean. Ongoing implementation of the full version of lean can require substantial investment before benefits are realised, and SMEs may be more restricted in this regard in terms of available financial resources or ability to invest upfront in sufficient time to support training and knowledge development (Mazanai, 2012).

SMEs can implement some of the tools, such as the Last Planner, 5S, etc., to enhance their performance and productivity. SMEs can do this without having to invest huge sums of money. As the SMEs grow, they can implement other tools that require substantial investment, such as building information modelling (BIM).

### *Is the organisational culture of construction SMEs in Ghana supportive of lean construction?*

The construction industry differs culturally from one country to another, and

therefore practices and procedures that are well suited to the culture of one country may not be suitable in other countries (Kheni, 2008). Evidence from the 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 successful lean implementation (Al-Swidi and Mahmood, 2011). Dahlgaard and Dahlgaard-Park (2006) have argued that appropriate culture cannot be compromised if a company wants to adopt lean successfully. A discussion of organisational culture is appropriate, as lean initiatives are normally undertaken at the organisation level, where changes occur away from the traditional management approaches to construction (Shang, 2013). According to Atuahene (2016), small firms in Ghana have a dominance hierarchy culture focused on 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 relations with employees and suppliers (Womack et al., 1990). Companies that have successfully implemented lean have argued that it would not have been possible without sustained employee and supplier engagement and support at all levels of the organisation (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). The organisational culture in the construction industry in Ghana will need to change if the industry is to accommodate lean initiatives.

## LEAN PRACTICES

Table 1 identifies lean practices applicable to construction, with a brief description of the tools, and the literature sources consulted. The categorisation was mostly informed by an analysis of IGLC conference proceedings, although other studies published elsewhere were also consulted.

Table 1A. Identified lean practices applicable to construction, description of the tools and references

| Lean tools | Brief description | References |
|---|---|---|
| Last Planner System | The Last Planner™ System (LPS™) 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); Habchi et al., (2016); 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. | AlNimr and Mohammed (2010); Salem et al., (2005) |
| Daily Huddle | Daily huddles are for communication, not only for managers to talk to employees, but also for employees to | Salem et al., (2005) |

| | | |
|---|---|---|
| Meetings | express themselves and learn from each other. | |
| 5S Process | 5S is a basic method for clean-up and organisation of the workplace. | 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. | |
| 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. | |
| 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. | 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 | |
| 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. | Rossiti et al., (2016); Liker and Meier (2006) |
| 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); Rybkowski et al., (2016); Koskela (2015) |

**Table 1B. Identified lean practices applicable to construction, description of the tools and references**

| Lean tools | Brief description | References |
|---|---|---|
| The Ishikawa | The Ishikawa diagram is a representation of a | Fuenzalida et al., (2016) |

| | | |
|---|---|---|
| diagram | cause-effect analysis that is carried out for any type of result. | |
| Location Based Management System (LBMS) | The Location Based Management System (LBMS) provides a much needed spatial element to planning and has strong optimization and forecasting capability that can help plan and steer the project towards its goals. | |
| 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. | |
| Six Minute (SMED) | SMED practices in project management can be seen as a method for fast tracking the project schedule. | |
| 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. | Hirota and Formoso (2001) |

Based on the lean construction tools identified within the literature cited in Table 1, the authors categorised these tools into three groups, namely

A. Tools that require less monetary investment to implement,
B. Tools that can be fully implemented by construction SMEs, and
C. Tools that can be partially implemented by SMEs.

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

Table 2. Three groups of lean tools

| Group / Lean tool | A | B | C |
|---|---|---|---|
| Last Planner System | × | × | |
| Increased visualisation | × | × | |

| | | | |
|---|---|---|---|
| Daily huddle meetings | × | × | |
| First-run studies | × | × | |
| 5S process | × | × | |
| 5 Whys | × | × | |
| 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 | × | × | |
| Single-minute exchange of dies (SMED) | × | × | |
| Action learning | × | × | |

Researchers such as Rose et al. (2011) and Salem et al. (2005) have confirmed that tools such as 5S, kanban cards, SMED, kaizen, increased visualisation, Last Planner, daily huddle meetings, first-run studies, poka-yoke, and andon are the least costly, and can be implemented by SMEs. A review of the literature on the other lean construction tools (5 Whys, concurrent engineering, Choosing by Advantages, A3 report, the Ishikawa diagram, LBMS, heijunka, VSM, and action learning) shows these tools as not being capital-intensive, and therefore not within the reach of SMEs. The authors will subsequently validate these other lean construction tools. Considering the poverty levels in Ghana, the authors recommend that lean tools that require less monetary investment be implemented by construction SMEs, as can be seen in Table 2. SMEs can implement these tools without having to invest that much, and as the SME grows, it can implement tools such as BIM, which requires some investment in software and hardware. SMEs can implement some aspects of BIM, such as 3D, which does not require substantial investment.

## ADOPTING LEAN PRACTICES BY CONSTRUCTION SMEs IN GHANA

A change in mindset is required before embarking on lean implementation (Herrala et al., 2012; Emuze and Ungerer, 2014). This is because a fundamental part of implementing any lean strategy is a change of mindset, and a change of organisational culture (Liker and Meier, 2006). Top management must intervene, and this requires that people behave differently, starting with changing their conventional mindsets. As this process is repeated, a different set of beliefs and values – a new organisational culture – will ultimately evolve. This, however, requires a long-term

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, such as the Lean Construction Institute (LCI), to offer special training for contractors in Ghana on strategies for applying the lean thinking concept within the industry. Furthermore, there should be deliberate government policy to implement lean, particularly within public-sector construction works. There is also a 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 is becoming much more competitive. The benefits of implementing lean are substantial, while the cost of not being able to meet project goals may be significant. The primary objective of this paper was to propose lean construction tools that can be implemented within the construction SME set-up. This is against the backdrop of SMEs' lack of the needed resources to implement lean construction. Through a review of the literature, this paper has proposed lean construction tools that can be implemented within the construction SME set-up. The study found that SMEs can implement some lean tools, such as the Last Planner, 5S, etc., which will not require having to invest huge sums of money. This is an important finding, as some authors have argued that SMEs do not have the capacity to implement lean construction. This is preliminary research from 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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