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Holistic Algorithms for Examining the Non-Performance of Lean Method of Construction for Accelerating Efficient Utilization of Lean Construction Methods in Ghana

Napoleon Kuebutornye DK [1] Michael Tsorgali[2] Nongiba Akanam Kheni[2]
1. Faculty of Built Environment, Bolgatanga Technical University, P. O Box 767, Bolgatanga, Ghana
2. Faculty of Technical Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, P. O Box 1277, Kumasi, Ghana
* E-mail of the corresponding author: knapoleon9@yahoo.com

Abstract
Lean construction process is key to efficient, sustainably and economical project delivery success of construction project; however, globally, LC is a critical tool in construction project management in the construction industry; especially in the developing economies of which Ghana is no exception. This study sought to examine nonperformance of lean construction method to enable efficient utilization of lean construction methods for sustainably, economical and proficient project delivery in Ghana. The study adopted mixed research approach. Using empirical data obtained from administration of questionnaires to Operational Managers/Staff and Expect personnel in Ghana; the data was analyzed using NVivo 11 software method. The study indicated that the surveyed participants across the cases had limited understanding, familiarity, and usage of lean construction methods. The study further revealed that the lean implementation challenges identified, in addition to the key indicators which represent the performance of LCM, were all significantly negative from the statistics of the study, establishing the non-performance of LC in Ghana. The study concluded that the adoption of lean principles will lead to more economical and sustainable projects in the industry. As a recommendation, it was suggested that management develop LC policies to guide the implementation and commit to the methods to enable efficient utilization of LC.
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1. Introduction

Lean construction is widely recognized as a critical improvement module for the construction industry for improving construction operations. Various studies (Salem et al., 2006; Cho and Ballard, 2011; Bhamu and Sangwan, 2014) have demonstrated the effectiveness of lean construction in addressing various issues in the construction process, such as low productivity, poor quality, increasing costs, low job satisfaction, and waste generation.

Despite the various advantages of lean construction, successful adoption of the approach is quite challenging for most firms. Jadhav et al. (2014) pointed out that firms have a variety of problems and issues related to the failure to implement a lean approach. Similarly, Nordin et al. (2010) stated that applying lean thinking is a challenge for most companies. As with any other change, there is a lot of opposition to the implementation process. Thus, it is necessary to identify and overcome these roadblocks to create a platform for organizational and individual change preparation (Jadhav et al., 2014).

Several studies have investigated the challenges of implementing lean globally. Some of these studies have focused on the obstacles to lean implementation (Olatunji 2008; Abdullah et al. 2009), while others have focused on the challenges of lean practice execution (Johansen and Porter 2003; Alarcón, 2005). If not addressed properly, these impediments can negatively affect the lean implementation process and project performance (Leong and Tilley, 2008).

Similarly, the fragmented nature of the industry, extensive use of subcontractors, lack of long-term relationships with suppliers, delays in decision making, and waste accepted as inevitable were identified as the five most significant obstacles to the implementation of lean construction in Ghana, based on mean scores of the factors identified. As in previous studies (Ayarkwa et al., 2011), fragmentation and subcontracting were seen as significant hurdles to implementing lean principles. In light of this, the study aims to examine the non-performance of the lean method of construction in Ghana to enable the efficient utilization of lean construction methods for sustainable, economical, and proficient project delivery in Ghana.

2. Lean Construction Method

The Manufacturing Extension Partnership's Lean Network of the National Institute of Standards and Technology defines Lean as a systematic method for eliminating waste, continuously improving processes, and maintaining a

production rate that meets customer requirements (Kilpatrick, 2003). Examples such as Toyota Production System, Ford Production, and Japanese Lean Construction demonstrate the application of Lean in various operations, including manufacturing and construction.

The objective of Lean manufacturing is to produce products that meet customer requirements and improve the efficiency of the production system (Aziz & Hafez, 2013).

Lean production system, according to (Marhani, Jaapar, & Bari, 2012), is a collaborative approach of different factors aimed at maximizing benefits or output with minimal waste.

According to Egan, (1998), the main concern associated with 'rethinking construction' is the evolution of the industry's culture, organizational, and managerial style in order to overcome barriers, attitudes, roles, relationships, actions, and communications among project stakeholders (Koskela, 1998; Sarhan and Fox, 2013). Similarly, culture, organizational and leadership styles are critical pillars for continuous improvement, which imply persistent delivery of increased value and mutual competitive advantages (Abdullah, et al., 2009; Koskela, L. 1998). Team members can find opportunities to reduce activities that do not bring value through stakeholder participation and continual improvement (Meng, X., 2012; Sarhan, S., & Fox, A., 2012; Womack, James P. et al., 1996). Conversely, Lean construction aims to achieve a balanced use of people, materials, and resources, allowing a company to cut expenses, remove waste, and complete projects on schedule (Hall, M. and Purchase, D., 2006; Houvila, P. and Koskela, L., 1998; Lim, V. L. J., 2008; Koskela, L., 1998).

2.1 Lean Construction Drivers in Ghana

The drivers to LC are reasons which push organizations to adopt the principles of lean (Bashir et at., 2015). This segment evaluates literature on the drivers to the adoption of LC principles.

Economical Advantage

Economical advantage comes is either from having lower costs than competitors or being able to charge higher prices due to differentiated products (Lewis and Dehler, 2000": According to Mohamed (2016), lean organizations are able to reduce waste in processes, resulting in added value for clients and improving the quality of work. Accordingly, Melton, (2005) suggests that companies have achieved a competitive edge through lean approaches by minimizing waste and providing more value to clients. The implementation of lean and its tools can provide impressive productivity advances, enabling companies that have successfully adopted LC to better accommodate customers' needs by reducing waste in the system, thereby creating a competitive advantage that is difficult for other firms to compete against (Nicholas, 2018; Rossiti et al., 2016; SmartMarket Report, 2013).

Uninterrupted Improvement

Continuous improvement is a philosophy that is geared towards sustaining improvements that are targeted at minimizing wasteful activities. It involves a collaborative effort of everyone to make the improvements (Bhuiyan and Baghel, 2005). However, without the support and commitment of top management, these improvements will not occur. Continuous improvement is central to the practice of LC principles and it has also been conceptualized as innovation in itself (Alves et al., 2009). Continuously improving on processes lead to an added advantage of improved productivity which will then lead to increased revenue and profits (Kyere, 2017; Ogunbiyi, 2014; Bashir, 2013; Ross and Associates, 2004).

Policies and Regulations of Government

Several studies such as (Kyere, 2017; Ogunbiyi, 2014, SmartMarket Report, 2013; Radnor and Walley, 2008) have argued that governments through its policies and regulations drive the adoption of LC principles in organizations. Consequently, government regulations and ISO standards (9000 and 1400) have become central in companies reputation and image in the corporate world. For example in the United Kingdom, there is a requirement for the construction sector to aim for LC. This understanding has been increased following the Egan Report. Governments continue to be major stakeholders in the construction industry and therefore its policies and regulations drive changes (Ogunbiyi, 2014). Therefore, the government acts as a driver for the implementation of management principles such as LC as posited by several researchers.

Patron Demand

The construction industry is continuously changing, with clients driving these changes (Ashworth, 2010; Kelly et al., 2008). Clients are increasingly seeking innovative approaches to project construction and management. To achieve their project goals, these clients require a structured method for project management (Kelly et al., 2008). According to the SmartMarket Report (2013), all general contractors recognize the influence of clients in driving the implementation of LC principles. Client influence plays a major role in the initial implementation of lean principles, driving and setting the framework of the process throughout all phases of the project. The demand for the application of LC principles by clients is a significant factor in the successful implementation of LC within organizations (Daoud et al., 2019; SmartMarket Report, 2013).

Cost Savings

Cost savings have been identified as a driver for implementing lean in organizations (Ogunbiyi, 2014; Bashir, 2013; SmartMarket Report, 2013). Many organizations have embarked on the lean journey with the intention of

reducing the cost of works (Friedman, 2008). Jeff (2010) indicates that, the popularity of LC concepts has increased dramatically as firms strive to reduce their total cost of managing construction projects. The underlying philosophy of LC, which aims at eliminating or minimizing waste, leads to an improvement in the quality of works, thereby reducing production costs for contractors (Kempton, 2006).

2.2 Lean Construction Barriers

Although many countries have benefited from implementing lean construction principles in their construction projects, studies have shown that several obstacles and barriers hinder the adoption and expansion of lean construction.

Shang and Sui Pheng (2014) conducted a study of major Chinese construction firms and found that the top three barriers to implementing lean construction were the lack of a long-term mindset, absence of a lean culture in their organizations, and usage of multi-layer subcontracting. Companies like Toyota, which have a strong focus on long-term goals, have been successful in implementing lean principles (Dupin, 2014; Shang and Sui Pheng, 2014).

Aigbavboa et al. (2016) conducted a questionnaire survey among South African construction businesses and discovered numerous hurdles to Lean construction adoption in the South African construction sector, including "inadequate pre-planning," "unskilled labor," and "poor communication." Sarhan and Fox, (2013) performed a questionnaire survey of 140 construction experts to gather their feedback, which revealed that cultural concerns are a factor in the application of lean construction in the United Kingdom.

In a survey of medium to large contracting businesses in the construction sector in Singapore, Dulaimi and Tanamas, (2001) discovered that management of contracting firms were hesitant to offer their staff training in lean construction methods. According to Omran and Abdulrahim, (2015), the most difficult hurdles to the adoption of lean construction in the Libyan construction sector were the "lack of organizational culture" and "lack of knowledge and skills" that enable teamwork.

Ayalew et al. (2016) reported that 74% of respondents believe that the most significant barrier to lean construction deployment in the Ethiopian construction industry is the lack of understanding regarding lean construction techniques and the use of untrained labor. Adegbembo et al. (2016) also identified a lack of understanding and awareness among Nigerian practitioners as a key hurdle to lean construction adoption.

According to Ciarnien and Vienaindien, (2015), the biggest barrier to the adoption of lean construction in Lithuania is a lack of knowledge and motivation, which is cited by 74% of respondents. Al-Aomar, (2012) identified major hurdles to implementing lean construction techniques in Abu Dhabi's construction sector, including "lack of lean awareness among top management and employees," "improper training and the high cost of lean training," and "lack of lean experts and knowledge of which are more common in poor countries like Ghana.

3. Research Methodology

The mixed research method, which enables researchers to combine quantitative and qualitative research techniques (Myers and well, 2010), was used in this study. A mixed research design strategy was employed, which involved gathering both quantitative and qualitative data through a structured questionnaire and structured interview questions with key figures, including operational managers, operational staff, and experts of lean methods, purposefully chosen in the construction industry in Ghana (Tosetto et al., 2016). Qualitative methods were used to explain patterns and attitudes regarding the intellectual perspective and interpretation of participants (Brown et al., 2017), discover trends in thought and opinion, and to gain an in-depth understanding of the issue under investigation. On the other hand, quantitative data was collected through the use of instruments to test a theory or hypothesis (Yilmaz, 2013). The interview questions were answered by three operational managers, operational staff, and two experts of lean methods. Ten (10) respondents who the researcher believed had knowledge and understanding in lean construction were purposefully searched and selected for the research due to the limited availability of operational managers/staff and experts in the area of the research.

NVivo 11, a computer-assisted qualitative and mixed method research data analysis software, was utilized to facilitate data management and analysis.

4 Findings and discussion

4.1 Lean Construction Methods Usage

The researcher aimed to investigate the usage of Lean construction methods and to determine any potential nonperformance of the approach in Ghana. In this regard, the participants provided the following statements: -

Participant (A) stated that no significant implementation of Lean Construction methods is being done. Two other participants (C and D) also mentioned that their firms do not have a structured Lean Construction Method in use, but they are utilizing some of the soft Lean tool principles related to people and relations (Culture,

Respect, Collaboration, Trust, and Transparency). Participant (D) also pointed out that some aspects of Lean are being practiced, but not in a systematic way, and only soft Lean practices like motivation are being followed rather than hard tools like the Last planner system.

The final interviewee (E) mentioned that they use Building Information Modelling (BIM) as a Lean tool, which has helped them minimize physical and process waste and maximize value generated for the client. This aligns with the findings of Koseoglu et al. (2018), which investigated the interactions and synergies between Lean and mobile BIM adoption at building sites. Both Lean and BIM are tools aimed at improving the productivity and proficiency of construction professionals and achieving timely and cost-effective project completion.

On the other hand, from the result of the data majority of the respondents were not familiar with LC tool or principle. Out of the five (5) respondents only one (1) was familiar with just one lean construction tool. Across the cases all the respondents explained that LC is about waste elimination. These explanations as put forth by the respondents exhibit a limited understanding of lean which concentrates on understanding customers' needs and creating value (Hines et al., 2004). Unfortunately, this was not understood by the respondents establishing the reason of the non-performance of LCM proving the non-performance of the LCM.

Feather more, the effectiveness of implementing both hard and soft lean practices are supported by the results of Shah and Ward's (2007) study, in which the success of lean implementation was as a result of a complex system of interrelated socio-technical practices, it is also clear that most of the respondents cannot relate to the soft and hard lean toots in practice showing further the non-performance of LM.

In conclusion, the interviews conducted revealed that there is limited utilization of lean construction methods in the construction industry in Ghana, as previously reported by Ankomah et al., 2015), Ayarkwa et al., 2012), and Kpamma, 2010).

4.2 Lean Construction Methods Challenges

To explore the challenges of implementing lean construction methods in Ghana and the reasons for the non-performance of the Lean Method, further investigation was necessary.

The participants mentioned the following as challenges to the implementation of Lean construction principles: the absence of policies, lack of commitment from top management, resistance to change, lack of knowledge and understanding, cultural barriers, and lack of communication. These assertions by the respondents confirm earlier studies such as Ankomah et al., 2015) and Ayarkwa et al., 2012), which found a low level of familiarity with LC principles in the Ghanaian construction industry.

Typically, LC should be taken as a holistic management theory that requires long-term thinking to gain the benefits that come with implementing its principles (Herrala et al., 2012).

From the above-mentioned challenges, it is very clear that the implementation of the Lean Construction method is significantly hindered by basic problems. These problems further entrench the reasons behind the non-performance of the Lean Construction method in Ghana.

4.3 Issues of Lean Construction methods utilization in Ghana

Based on the main themes and subthemes identified through mind mapping, the researcher grouped the data presented in table 4.1 into two themes: Issues of Lean Construction Methods utilization in Ghana, which aims to establish the utilization of LCM in Ghana, and Critical Issues of the Non-performance of Lean Construction Methods utilization in Ghana, which addresses the nonperformance of LCM.

despite the advantages and benefits of LCM mentioned by the experts, the majority of organizations (70%) do not practice LC principles and feel that LCP has not been successful. Additionally, 80% of respondents stated that they do not have management support regarding the implementation of lean construction. These data suggest that LCM is not being utilized to a large extent in Ghana.

4.4. Critical Issues of the Non-performance of Lean Construction methods utilization in Ghana

Based on the results shown in Table 4.1, several critical issues have emerged. Firstly, 90% of the respondents reported that they lack information on key performance indicators that can drive continuous improvement. Secondly, the same percentage of respondents stated that their organizations do not have information on up-to-date key performance indicators. Thirdly, 60% of the companies and their suppliers lack confidence in the lean construction principles approach. Finally, all respondents agreed that they encountered challenges in implementing lean construction principles, and 90% reported that their companies do not have policies that establish continuous improvement of lean construction principles.

The table 4.1 also revealed that 100% of the respondents agreed that their companies do not engage in continuous learning processes by organizing workshops with the assistance of lean consultants for their employees. Regarding communicating the benefits of lean construction to employees, 90% of the respondents stated that there is no communication about it.

Finally, Table 4.1 illustrates that the key indicators representing the performance of LCM are significantly negative, providing evidence of poor performance of LC in Ghana.

5.0 Conclusion and Recommendation

The implementation of lean construction in Ghana requires a change in mindset, as it involves a transformation in thinking, collaboration, flexibility, commitment, discipline, and a broad system-wide focus. However, the study has revealed that there is a lack of familiarity with LC tools and principles, which is coupled with numerous challenges faced by LC, resulting in its non-performance in Ghana. Therefore, the study recommends that the construction industry should move away from traditional project management and embrace LC. To increase awareness and utilization of LC tools, companies should develop a policy to educate employees on lean construction principles with the assistance of a lean specialist. A change in mindset and organizational culture is necessary for efficient LCM implementation that can lead to continuous improvement of all activities.

Therefore, there is sufficient evidence of the non-performance of LCM in the Ghanaian construction industry. Addressing the challenges faced by LC can lead to efficient and sustainable project performance in the industry in Ghana.

Table 4.1 Lean Construction Methods Utilization in Ghana

Statement			Percentage	
	Yes	No	Yes %	No %
Do you think Lean Construction is beneficial for an Affordable Housing Scheme in Ghana?	10	0	100	0
Do you think that Lean Construction Techniques could improve productivity in proficient and sustainable project delivery in Ghana?	10	0	100	0
Do you think that Lean Construction Techniques when used at site level could generate cost savings?	10	0	100	0
Are you practicing lean construction principles in this organisation?	3	7	30	70
Do you have any information showing up to date key performance indicators that can drive the use of continuous improvement?	1	9	10	90
Do this company have management support with regards to lean construction implementation?	2	8	20	90
Do the company and its suppliers have confidence in the lean construction principles approach?	2	8	20	80
Have you encountered any challenges in the implementation of lean construction principles?	1	9	10	80
Does this company engage in a continuous learning process by organizing workshops for employees with the assistance of lean consultants?	0	10	0	100
Do you have any means of communicating lean construction benefits to your employees?	1	9	10	90
Do you feel that lean construction principles have been successful in your organisation?	3	7	30	70

(Source: Data Analysis, 2023)

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