THE STATE OF ADOPTION OF LEAN CONSTRUCTION IN THE TANZANIAN CONSTRUCTION INDUSTRY

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ABSTRACT

Lean has been able to minimise waste, improve quality, and increase value for money in the construction industry. However, the extent of adoption of lean construction concepts is yet to be determined for the Tanzanian construction industry. The purpose of this study is to investigate adoption of lean construction concepts, and to determine the barriers to implementation of such concepts. Data were collected from practising consulting and contracting firms, using self-administered questionnaires. Forty-six of the 60 questionnaires distributed were completed and returned, and they were analysed using the Statistical Package for the Social Sciences (SPSS). The findings indicate that the lean concept adopted in the Tanzanian construction industry is teamwork. It was consistently found that the main barriers to adoption of lean construction in the Tanzanian construction industry are a lack of technical skills and inadequate design and client information. Generally, there is a low rate of adoption of lean construction in Tanzania, as most of the listed concepts are not yet sufficiently recognised by the respondents. The study recommends promoting lean construction concepts, and creating awareness of such concepts, through continuous training, open communication channels, and an embracing of lean by project participants and construction-related associations. This paper makes a contribution to the body of knowledge on the subject of lean construction adoption within the previously unexplored context of Tanzania.

Keywords: lean construction, concepts, barriers, benefits, principles

INTRODUCTION

The Tanzanian construction industry contributes to national growth, through the gross domestic product (GDP), gross fixed capital formation, creation of employment opportunities, and industrial productivity. Despite this significant contribution, the industry faces a number of performance challenges, such as inadequate funding, a lack of technical skills, and bureaucratic procurement procedures, most of which have been

explained in reports and studies by the NBS (2013), UNESCO (2010), and Muhegi (2007). For a long time, construction industries in developing countries have continued to perform inadequately (ILO, 2003; Rwelamila, 2009). Projects are delivered beyond the expected budget and duration, there is a high incidence of waste, and quality is low (ILO, 2003). The inadequate performance of the construction industry is linked to inappropriate approaches to projects, and non-use of lean construction. Lean construction involves a continuous and methodical pursuit of delivering value for customers through minimising waste and improving quality and efficiency in the construction industry (Sniegowski and Royer, 2012). Lean construction is a concept that has been introduced extensively in developed countries, and in some developing countries, and its application within the industry is reported to have many benefits (Sniegowski and Royer; 2012; Ballard and Howell, 2003). Dulaimi and Tanamas (2001) and Gleeson and Townend (2007) point out that lean construction has realised significant improvements, particularly on complex, uncertain, or quick projects.

Although lean construction concepts have recently received attention as a modern way of improving construction performance and labour productivity, the industry is slow in taking up lean concepts (Matias and Cachadinha, 2010; Alinaitwe, 2009). The slow uptake of lean construction is linked to a number of barriers. Alinaitwe (2009), Matias and Cachadinha (2010), Bashir et al. (2015), Ayarkwa et al. (2011), Sarhan and Fox (2013), Shang and Pheng (2014), Wandahl (2014), Devaki and Jayanthi (2014), Olamilokun (2015), and Aigbavboa et al. (2016) have determined the barriers to implementation of lean construction in both developed and emerging economies. These barriers have been categorised into technical barriers, managerial barriers, barriers related to human attitudes, financial barriers, barriers related to the process of lean construction, government barriers, and educational barriers.

Generally, lean construction practice is yet to be appreciated in the construction industry, in both developed and developing countries. Lean construction practice, and barriers to its implementation in the construction industry, is an area of the industry that remains unexplored in Tanzania. This research seeks to shed light on this area. To determine the state of adoption of lean construction in Tanzania, a descriptive type of research was adopted. Data were collected using self-administered questionnaires and a literature review. Data were analysed by using frequencies, descriptive statistics, and independent-samples t-test features of the SPSS. This paper reports on the state of lean construction practice in Tanzania, and it reveals the barriers to its implementation. The findings of this study are intended to initiate debate on lean construction practice among researchers in construction management in the country. In addition, the paper documents previous work on adoption of lean concepts, and barriers to their implementation, and it provides a description of how the research was done, an analysis and discussion of the findings, and conclusions and recommendations.

AN OVERVIEW OF THE TANZANIAN CONSTRUCTION INDUSTRY

The construction industry in Tanzania, as in many other countries, contributes significantly to national growth, through the gross domestic product (GDP), gross fixed capital formation, creation of employment opportunities, and industrial productivity. According to the United Republic of Tanzania (URT) (2013), in volume terms, the construction industry accounted for an average of 6.8% of GDP in the period 2003–2010. In addition, URT (2013) data indicates that in terms of real output performance, growth of the construction sector was about 10.5% in 2010, and that this sector showed the highest growth rate after the telecommunications sector. The URT (2011) reveals that the contribution of the industry to gross fixed capital formation was over 50% in 2011. Similarly, the URT (2015), through the Integrated Labour Force Survey (ILFS) Analytical Report, discloses that in 2014 the construction industry employed 2.1% of the labour force in the formal sector, and 6.2% in the informal sector.

Despite its recorded performance, the industry still faces a number of performance challenges. These challenges, discussed in reports and studies by the URT (2013), UNESCO (2010), and Muhegi (2007), can be summarised as follows:

a) inadequate institutional coordination of planning between the construction industry and other sectors of the economy;
b) inadequate fiscal and non-fiscal incentives and motivation among workers;
c) insufficient skilled, qualified, and experienced personnel;
d) inadequate funding;
e) a lack of professional ethics, including corruption among some of the stakeholders;
f) use of inappropriate technologies that do not meet required construction standards;
g) competition from imported building materials;
h) transport bottlenecks in the distribution of construction materials;
i) inadequate management skills;
j) stiff competition/access to work opportunities, and
k) bureaucratic procurement procedures.

The URT (2010) discloses that there are three main extended problems to road projects. These are: road projects are not completed within the agreed-upon time; additional but avoidable costs are incurred; and there are weaknesses in the quality control system, which leads to early wear and tear of constructed roads. Some of these challenges can be minimised by adoption of lean construction in the industry. Nevertheless, the government has been putting in place measures to address these challenges. These measures include (Muhegi, 2007; URT, 2015):

a) restructuring of tender boards, to ensure separation of authority, by letting technocrats deal with the technical aspects, and letting politicians deal with ensuring checks and balances;
b) exemption of VAT and import duty on all generic construction equipment, as an incentive for contractors to procure equipment;

c) a significant number of affirmative policies in procurement, such as preference schemes, and adoption of bid declaration instead of bid security;
d) a review of the Public Procurement Act, 2004, and its Regulations, 2005, and replacement of it with the Public Procurement Act, 2011, and its Regulations, 2013, so as to eliminate bureaucratic procurement procedures and enhance transparency, and
e) an increase in the government's development budget, from 26% in 2015/16 to 40% in 2016/17 (URT, 2015).

LEAN IN THE CONSTRUCTION INDUSTRY

Lean construction principles

Womack and Jones (1996), and Bashir et al. (2015) identify and elaborate on five fundamental principles: value, value stream, flow, pull, and perfection. Value is ultimately defined by customer needs, through tools such as value management, quality function deployment, and simulation, so as to deliver client satisfaction (Gleeson and Townsend, 2007). It is suggested that after establishing the real value of a product or service, as determined by the final customer of an economic process, a lean transformation process will then seek to eliminate all wasted effort, materials, time, space, etc. from the set of all activities and operations (Lim, 2008; Wu and Wang, 2016). A product focus is essential, as it enables long-term dialogue to be started, while dealing with the nature of value, and how the product delivers it. In the end, the client requires a building that suits their purposes and provides value for money (Womack and Jones, 1996; Lim, 2008).

Value stream identifies all those steps required to make a product, for example the way value is realised, and it establishes when and how decisions are to be made. The purpose of the important technique of value stream is to understand how value is built into the building product, from the client's perspective. Value stream maps can be understood by identifying what action releases work to the next operation. Mapping not only brings choices to the surface, but also raises the possibility of maximising performance during construction. Under normal circumstances, maps are prepared at the project level, and are then deconstructed, to better understand how the design of planning, logistics, and operation systems works together to support customer value (Emuze and Saurin, 2016; Koskela, 1992). At strategic level, it offers a perspective on defining what is to be done to bring that product or service to market. Furthermore, the idea of identifying value streams such as the structure and the building envelope, and considering how these systems are to be designed, supplied, and constructed, offers a different way of organising for construction. Koskela (1992) and Wu and Wang (2016) believe that lean construction should be focused on value, rather than on cost only.

Flows are characterised by time, cost, and value. Resources (labour, materials, and construction equipment) and information flows are the basic units of analysis in lean construction (LC) (Womack and Jones, 1996; Lim, 2008). The literature shows that

there are controllable and uncontrollable flows (Womack and Jones, 1996; Lim, 2008). Controllable flows are those within the control of the manager, such as materials from the warehouse, or instructions from management. Uncontrollable flows are those beyond the control of the site manager/engineer, such as suppliers' provisions of resources, and design information. Importantly, flow is expected to achieve a holistic route through the means by which a product is developed (Emuze and Saurin, 2016; Gleeson and Townsend, 2007). In this case, LC works to eliminate places where value-adding work on materials or information is interrupted. Figure 1 illustrates the five principles that need to be considered when implementing lean construction.

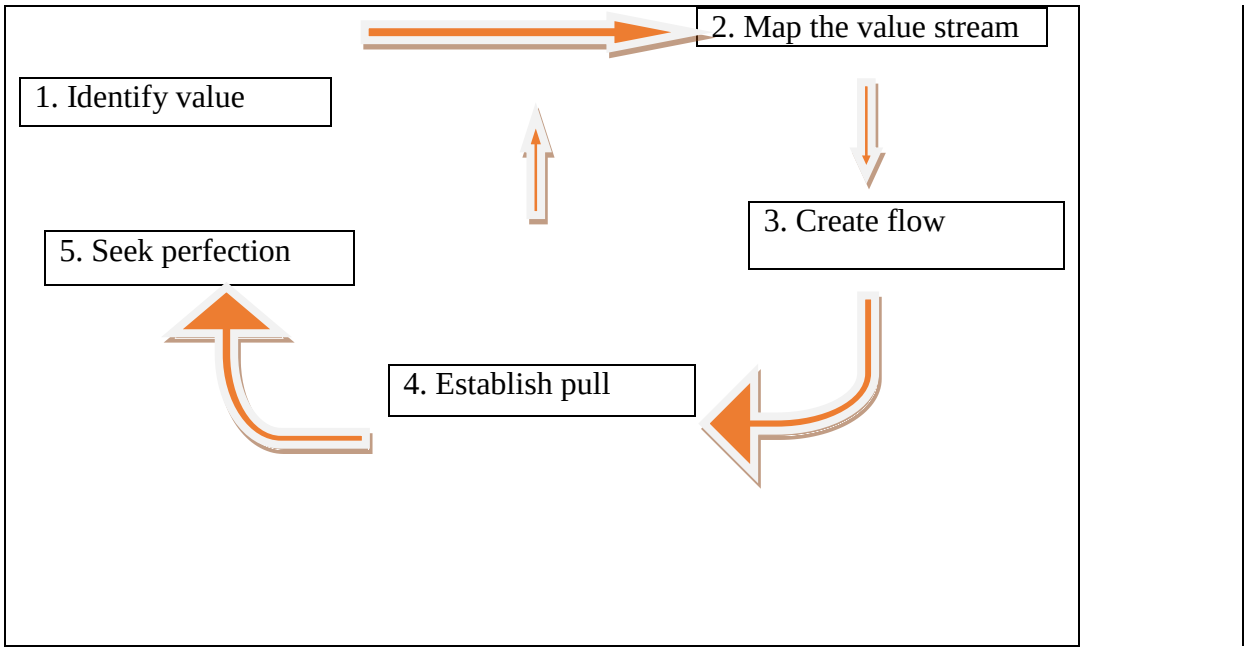

Figure 1: Lean construction principles (Source: Lean Enterprise Institute, 2009)

Each of the stages is necessary, and once one stage is implemented, impacts are noticed. Thus, lean principles can only be applied fully and effectively in the construction industry by focusing on improving the whole process, ensuring integration among project team members, and increasing transparency, particularly on issues related to waste elimination. As depicted in Figure 1, lean construction is a way of designing production systems so as to minimise waste of materials, time, and effort, in order to generate the maximum possible amount of value. Lean construction involves using the same principles as lean production, in order to reduce waste and increase productivity and effectiveness in construction work (Aziz and Hafez, 2013; Wu and Wang, 2016). The most important determinants of construction are supposed to be workflow reliability and labour flow, but lean construction has challenged the traditional view of the project

as transformation, and it embraces the concept of flow and value generation. It also shares the same objectives as lean production, namely cycle time reduction, elimination of waste, and variability reduction. Continuous improvement, pull production control, and continuous flow have long been the direction in implementation of lean construction.

Incorporating lean construction in the construction industry

Lean construction has a number of benefits; for this reason, it is important for stakeholders to incorporate LC in the construction process. Koskela (1992) asserts that there are many benefits when implementing LC in construction projects. The greatest benefit is that construction companies can reduce construction costs, by using the exact quantity of materials required, and by reducing waste. LC also produces better results in complex, uncertain, or quick projects (Salem et al., 2005). Table 1 lists the benefits that are claimed for implementation of lean construction in the construction industry in several emerging economies.

Table 1: Benefits of lean construction

Benefit	Project type	Country
It leads to a reduction in expected total construction cost and time.	Residential buildings	Brazil
It dramatically improves worker safety and customer satisfaction, and it increases value and reduces cost.	Housing construction	Denmark
It leads to a reduction in cycle time.	Building projects	USA
It results in improved structures, and it promotes discipline in planning.	Building projects	United Kingdom
It results in improved reliability in planning and executing projects.	39 low-rise buildings, 15 high-rise buildings, 11 heavy-construction and 12 light-industrial projects	Chile
It leads to improved planning and workflow reliability.	Heavy civil construction projects	Korea
It increases process reliability, it reduces total time, and it improves quality.	Residential buildings	Canada

It improves the supply system and the flow of the construction process, and it minimises waste.	Structural steel industrial houses	USA
It leads to a reduction in project duration and cost, and it improves communication flow.	Industrial houses	USA

(Sources: Mossman, 2009; Sniegowski and Royer, 2012)

There are a number of key concepts of LC that can be implemented by stakeholders. Lean concepts are listed by Harris and McCaffer (1997) (cited in Alinaitwe, 2009) and Marhani et al. (2013) as total quality management (TQM), Last Planner System (LPS), business process re-engineering (BPR), concurrent engineering (CE), product circles (PCs), teamwork, and value-based management (VBM). In addition, Alinaitwe (2009) lists other concepts, such as just-in-time (JIT), increased visualisation, and the 5S process. Most of these concepts are interrelated, and it is important to understand all the key concepts of LC, which may improve performance, while minimising construction waste. Figure 2 presents the key concepts by Marhani et al. (2013), who argue that most LC concepts are interrelated, and that it is therefore important for stakeholders to be responsible and choose the best LC concepts that can be implemented in their construction sites.

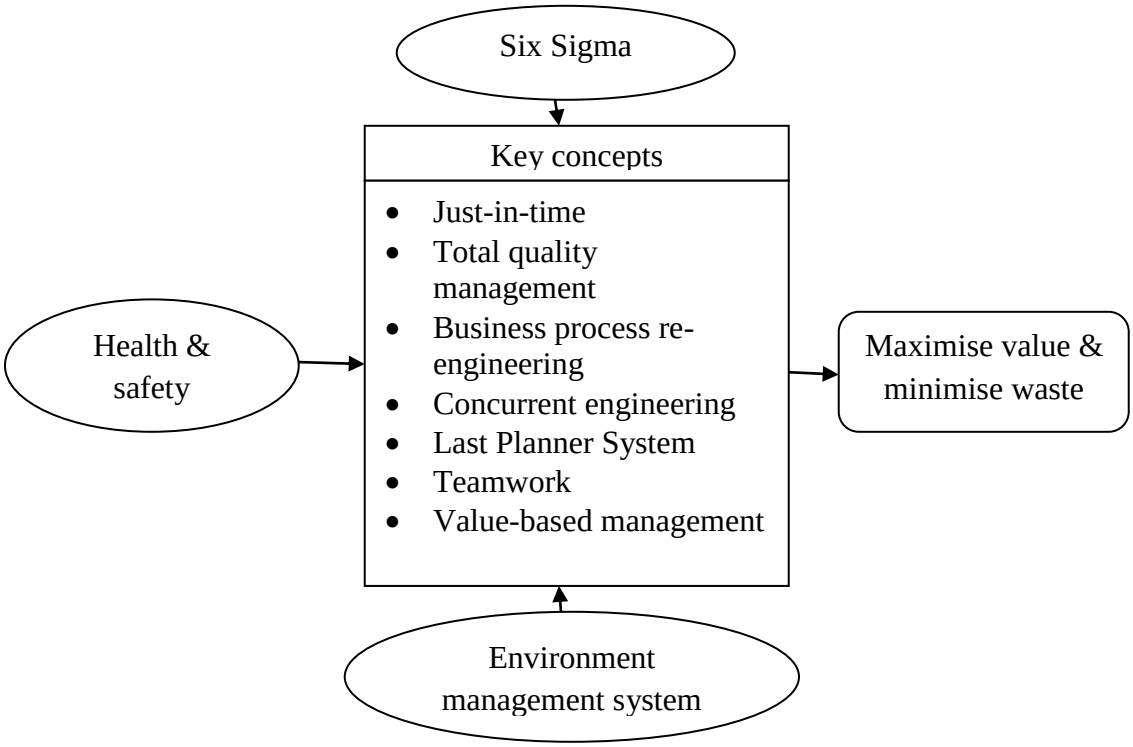

Figure 2: Key concepts (Source: Marhani et al., 2013)

The lean construction concepts assessed in this study have been defined by various authors. The definitions and explanations presented in Table 2 serve to enable a basic understanding of the lean concepts assessed.

Table 2: Operational definitions of LC concepts

Concept	**Explanation/definition of LC concept**	**Source**
Just-in-time (JIT)	JIT is highly dependent on high quality and reduced set-up times, where raw materials and components reach production operation in the desired quantities, and when needed, not before.	Ballard and Howell (1997)
Total quality management (TQM)	TQM is a philosophy that involves every organisation in the industry, in an effort to improve performance. It permeates every aspect of a company, and it makes quality a strategic objective.	Arditi and Gunaydin (1997)
Business process re-engineering	BPR stresses a radical reconfiguration of work processes and tasks, especially with	Davenport and Short (1990)

(BPR)	respect to information technology as an enabler.	
Concurrent engineering (CE)	CE is a design process where all life cycle phases of a product are considered simultaneously, from the conceptual stage through to the detailed design stage.	Kusiak (1993)
Last Planner System	The Last Planner refers to the last individual, typically the foreman, who is able to ensure predictable workflow downstream.	Fernandez-Solis et al. (2013)
Teamwork	Teamwork is working together in a group, where every member strives to fulfil their obligations.	Aziz and Hafez (2013)
Value-based management (VBM)	VBM is an extension of value management, and it applies process values as a means for achieving higher product values.	Wandahl and Bejder (2003)
Increased visualisation	Increased visualisation involves use of computer-aided visualisation in design (3D), planning (4D), and the construction process (3D).	Sacks et al. (2009)
Product life cycles (PCs)	Product life cycles involve a holistic view of the entire product life cycle, identification of suitable timing, and a systematic approach for lean production system design and its implementation.	Yang (2014)

Barriers to successful implementation of lean construction

Different authors have identified different barriers to successful implementation of lean construction. These barriers are related to fragmentation and subcontracting, procurement and contracts, culture and human attitude issues, the design/construction dichotomy, and educational issues. Alanaitwe (2009) determined the top 10 barriers that are easiest to overcome. Sniegowski and Royer (2012) state that many similar factors in the construction industry of both developed and developing countries act as obstacles to adoption of LC concepts. Similarly, Mossman (2009), Alanaitwe (2009), and Abdelhamid (2007) point out that in both developed and developing countries, fragmentation and subcontracting in construction hinder project participants from cooperating and learning together. Sniegowski and Royer (2012) explain that any form of procurement that tends to delegate design work to an external designer, without any follow-up or incorporation, separates the design work from the construction process, and therefore misses the lean aim of collaboration and integration. Gleeson and Townend (2007) point out that forms of contracts allow one party to impose power over another, an adversarial relationship that creates transaction costs which are considered waste, thus contradicting the philosophy of lean.

Abdelhamid (2007), Seymour et al. (1998), and Gleeson and Townend (2007) agree that applying lean thinking principles in the construction industry requires a new way of thinking about the entire process, in order to remove waste, create continuous flow, and radically enhance value to the customer. However, the culture of the construction industry is known to be opportunistic, prone to conflict, and resistant to change, which limits the lean process (Sniegowski and Royer, 2012). Obstacles related to culture and human issues have been documented as a lack of commitment, inability to work in a group, lack of a production process, cultural issues in getting subcontractors and workers to adopt the methodology in a comprehensive way, fear of taking risks, the wrong attitude to change, not viewing housekeeping as a continuous effort, a lack of team spirit among professionals, overzealous champions, dependency, a lack of incentives and motivation, a lack of trust, and fear of blame and contractual disputes. Another barrier to successful implementation of lean construction is the tendency of construction firms to apply traditional management concepts, as opposed to productivity and quality initiatives (Abdelhamid, 2007). According to Matias and Cachadinha (2010), it seems that commercial pressure to do the deal takes precedence over production issues.

Successful implementation of LC requires adequate funding to provide the relevant tools and equipment, adequate wages for professionals, incentives and reward systems, investment in training and development programmes, and use of a lean specialist, to provide guidance to both employer and employees during the initial implementation. Bashir et al. (2015) and Mossman (2009) have revealed some common financial barriers that need to be carefully addressed. These include inflation, inadequate funding of projects, unstable markets for construction, a lack of basic social amenities required for facilitating LC implementation, a lack of incentives and motivation, poor

remuneration for professionals, unwillingness by some companies to invest additional funds to provide training for their workers above and beyond the minimum legislative requirements, and a lack of commitment and support from top management. Successful implementation of LC or any new innovative strategy needs to be supported by top management. Top management has to provide sufficient time and resources to develop an effective plan and manage changes arising from the implementation process (Bashir et al., 2015). The benefits for top management of implementing LC are clear, namely increased productivity, and a reduction in time and number of accidents (Mossman, 2009). Design and adequate planning contribute significantly to the lean construction process. Any ignorance of the importance of these could have disastrous consequences in terms of wasted time, unnecessary costs, and prolonging of the overall process (Matias and Cachadinha, 2010; Sniegowski and Royer, 2012). There have been several attempts by researchers, academics, practitioners, and professional bodies in the construction industry to provide awareness and guidance regarding LC, and in some countries it seems that educational barriers could pose a significant threat to sustainable implementation of LC (Bashir et al., 2015; Emuze and Saurin, 2016). A lack of customer-focused and process-based performance measurement systems has been cited by Sniegowski and Royer (2012) and Alarcón and Serpell (1996) as barriers to implementation of lean construction. Marhani et al. (2013) and Olamilokun (2015) categorise barriers to implementation of lean construction as managerial barriers, technical barriers, human attitude barriers, barriers in the process of LC, educational barriers, government barriers, and financial barriers. Table 3 below summarises the classification of barriers to implementation of lean construction as technical barriers, managerial barriers, and human attitude barriers, as identified in earlier studies. Based on the literature, Table 3 reveals that barriers to implementation of lean construction in emerging economies (Alanaitwe, 2009; Ayarkwa et al. 2011) are mainly technical or managerial. By contrast, in developed countries (Sarhan and Fox, 2013; Bashir et al., 2015), barriers are technical, particularly in terms of inadequate lean construction knowledge, and related to human attitudes. However, barriers that remain common to both types of economies (Alanaitwe, 2009; Bashiri et al., 2015; Sarhan and Fox, 2013; Ayarkwa et al., 2011; Wandahl, 2014; Shang and Pheng, 2014; Devaki and Jayanthi, 2014; Olamilokun, 2015; Aigbavboa et al., 2016) are technical barriers and managerial barriers.

Table 3: Categories of barriers to implementation of LC

Source	Type of barrier		
	Technical	**Managerial**	**Human attitudes**
Matias and Cachadinha (2010)	Lack of technical skills, inadequate training, poor understanding and awareness, poor teamwork skills, illiteracy, and computer illiteracy		Ignorance of human resource management and development
Olamilokun (2015)	Inadequate exposure to the requirements for lean implementation, inaccurate and incomplete designs	Inadequate pre-planning	Corruption, misconceptions about lean concepts
Ayarkwa et al. (2011)	Lack of technical capabilities, lack of financial resources	Lack of proper planning and control, lack of teamwork, poor project management, poor communication between parties	
Sarhan and Fox (2013)	Lack of adequate lean awareness and understanding	Lack of commitment from top management	Cultural and human attitudinal issues
Alanaitwe (2009)	Lack of buildable designs, not using standard components, lack of project team skills	Lack of participative management style for the workforce, not having compatible management leadership, lack of steady work engagement, lack of communication within teams, not understanding the needs of customers, i.e. internal and external needs, and not	

		having a well-defined focus for the team	
Shang and Pheng (2014)	Insufficient management skills, multi-layer subcontracting	Lack of a long-term lean philosophy, lack of support from top management	Absence of a lean culture in the organisation
Wandahl (2014)	Lack of knowledge	Lack of commitment, cooperation, and communication	
Aigbavboa et al. (2016)	Extensive use of unskilled labour, the fragmented nature of the industry	Inadequate pre-planning, poor communication	Human attitudes towards change, lack of interest from clients
Devaki and Jayanthi (2014)	Lack of exposure to the need to adopt lean construction, a tendency to apply traditional management concepts	Uncertainty in the supply chain, lack of commitment from top management, a non-participative management style for the workforce	Culture and human attitudinal issues
Bashir et al. (2015)	Lack of lean knowledge, old-school thinkers not seeing the long-term goal, an old-school mentality, the high cost of implementation, the long implementation time	Lack of cooperation, lack of long-term forecasting and investment, lack of management support, and high expectations from management	A change in attitude and thinking is needed, and there are misconceptions about lean

METHODOLOGY

This is a descriptive type of research. According to Kumar (2011), this type of research attempts to systematically describe a situation, problem, phenomenon, service, or

programme, or to provide information. The main purpose of the study was to describe the trends of lean construction adoption in Tanzania. The study population included contractors from class I to class III, and consulting firms in the fields of architecture, engineering, and quantity surveying. The above-mentioned classes of contractors were chosen because it was deemed that they would have relevant expertise in construction, and that reliable data would thus be obtained from these groups. Contractors in Tanzania are registered in seven classes, namely classes I–VII. Class I is the highest class, and class VII is the lowest. The classes are broken down as follows: classes I and II (large contractors), class III (medium contractors), and classes IV–VII (small and emerging contractors). It was expected that the consultant subsample would supplement information obtained from the contractor subsample. Purposive sampling was used to select the respondents, as it was deemed that the respondents have knowledge of lean construction. Another consideration was availability and willingness of respondents to participate in the study. A sample size of 60 respondents was decided on, consisting of 12 architects, 13 quantity surveyors, 15 engineers, and 20 contractors. The selected sample size was such that it was sufficient to set a baseline for further studies on the subject (Oyediran and Akintola, 2011).

A literature review and questionnaires were used to collect data for the study. Previous work on the subject and gaps in the research were determined through a review of the literature. Questionnaires consisted of both open-ended and closed-ended questions that were logically related to the research topic. The content, the structured responses, the wording of the questions, and the question sequence were the same for all respondents. Of the 60 questionnaires distributed, 46 were completed for purposes of analysis, which equates to a response rate of 76.7%.

Data were analysed using the SPSS software package version 20. Descriptive statistics, namely frequencies, descriptive, and a comparison of means (independent-samples t-test), were used. To validate these results, lean construction concepts were extracted from the literature, mainly from Harris and McCaffer (1997) (cited in Alinaitwe, 2009) and Marhani et al. (2013). Respondents were requested to indicate their level of adoption, on a scale from 1 to 5, where 1 represents “No idea”, 2 represents “Not at all”, 3 represents “Used on average”, 4 represents “Used”, and 5 represents “Mostly used”. Similarly, barriers were extracted from the literature, and respondents were requested to agree or disagree, using the response options of 1 (“disagree”), 2 (“agree”), or 3 (“strongly agree”).

ANALYSIS AND DISCUSSION

Respondents’ level of experience

The majority of respondents (67.4%) had experience of more than 5 years working in the construction industry, and the rest (32.6%) had less than 5 years’ experience.

Awareness of lean construction in the Tanzanian construction industry

Figure 3 depicts the level of awareness of lean construction. Only 37% of respondents indicated that they were familiar with lean construction. Thirty-five percent of respondents indicated that they were somewhat familiar with lean construction. Surprisingly, 28% of respondents were not aware of lean construction. This implies that the majority of respondents have little or no knowledge of lean construction. However, the same respondents were able to rank adoption of lean construction concepts and associated barriers, simply because they have knowledge of the concepts as normal practice in construction.

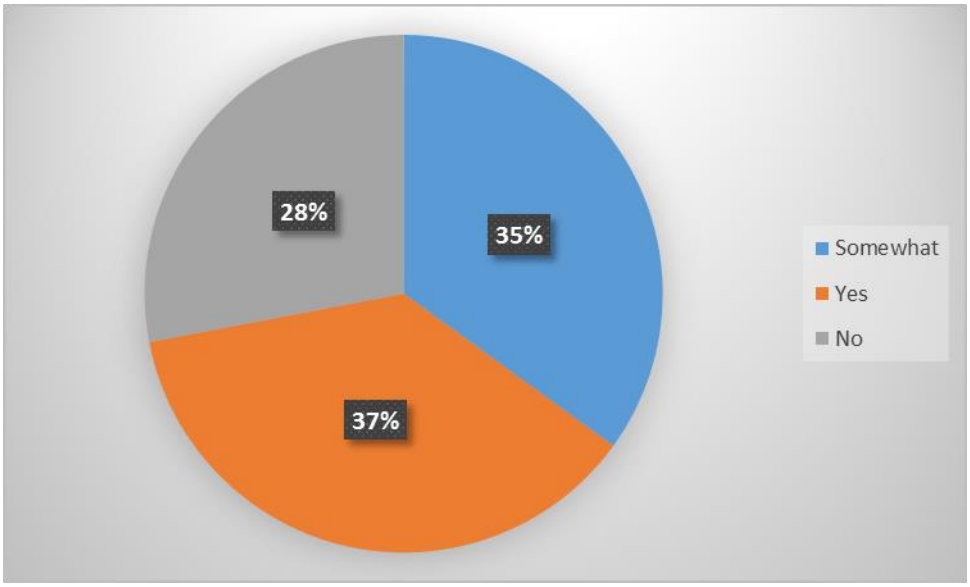

Figure 3: Familiarity with lean construction

Lean construction practice in the construction industry

Table 4 summarises the findings with regard to respondents' use of various lean construction concepts and associated lean concepts. Prior to indicating adoption of lean construction, respondents were to indicate if they had ever been involved in lean construction. Their responses were the same as those for awareness of lean construction, that is, 37% responded "yes", 35% responded "no", and 28% responded "somewhat". The results indicate that only total quality management (TQM), teamwork, and value-based management (VBM) had mean scores of $3.60 \leq 2.5$. The other concepts are almost not used at all. It should be noted that total quality management (TQM) and value-based management (VBM) are not lean concepts, but are associated lean concepts. The only remaining lean concept, namely teamwork, and the two associated concepts, namely total quality management and value-based management, are thus the only concepts used in lean construction practice in Tanzania. TQM and VBM are concepts that were mentioned by Harris and McCaffer (1997) (cited in Alinaitwe, 2009) and Marhani et al.

(2013). The conclusion that can thus be drawn is that Tanzania relies only on the lean concept of teamwork to implement lean construction. Teamwork is working together in a group, where every member strives to fulfil their obligations. Teamwork is a tradition in the construction industry, as each project brings together people from different backgrounds to work together. However, to realise this endeavour, project team members need to focus on their respective responsibilities, so as to achieve one goal, namely to deliver the project in line with predetermined objectives. While a number of studies (Harris and McCaffer, 1997, cited in Alinaitwe, 2009; Marhani et al., 2013) identify teamwork as a concept of lean construction, teamwork and other concepts have also received negative criticism. Green (1999) explains that the concepts of quality and teamwork have been blamed for translating into control, exploitation, and surveillance of the workforce. This means that while teamwork is one of the concepts in adoption of lean construction, its usefulness can be questioned if it is used in such a way that the workforce feels that they are being oppressed, or that they are working in a stressful environment.

Table 4: Use of lean construction concepts in the construction industry

Lean construction concept	N	Mean	SD	Ranking
Total quality management (TQM)	10	3.60	2.319	1
Teamwork	45	3.40	1.468	2
Value-based management (VBM)	10	2.70	1.418	3
Product life cycles (PCs)	45	2.47	1.307	4
Just-in-time	9	2.44	1.236	5
Concurrent engineering (CE)	44	2.16	.987	6
Business process re-engineering (BPR)	45	2.04	1.086	7
Last Planner System (LPS)	45	2.02	1.215	8
Increased visualisation	8	2.00	1.414	9

Experience and lean construction involvement

Table 5 presents a summary of the influence of work experience on involvement in lean construction. Experience was categorised as less experienced (≤ 5 years) or experienced (> 5 years). Using group statistics, the results indicate that with the exception of TQM and PCs, where less experienced respondents have been involved in lean construction, experienced respondents have been slightly more involved in lean construction than have been less experienced respondents. Analysis using the independent-samples t-test reveals that there is no significant difference between experienced and less experienced respondents in involvement in lean construction. This suggests that lean construction in the Tanzanian construction industry is yet to be appreciated. This finding confirms the findings of Matias and Cachadinha (2010) and Alinaitwe (2009) that the construction industry is slow in taking up lean concepts, which is the reason why experienced respondents were not conversant with lean construction concepts. This also implies that

knowledge of lean is limited in the construction industry. A number of studies (Matias and Cachadinha, 2010; Bashir et al., 2015; Sarhan and Fox, 2013; Wandahl, 2014; Devaki and Jayanthi, 2014; Shang and Pheng, 2014; Olamilokun, 2015) have suggested that inadequate lean construction knowledge is a barrier to lean construction implementation.

Table 5: Experience and involvement in lean construction

Concept	Level of experience	N	Mean score	SD	Levene's test for equality of variances	
					F	Sig.
C1	Less experienced	4	4.25	3.403	1.815	.215
	Experienced	6	3.17	1.472		
C2	Less experienced	14	1.79	1.051	2.004	.164
	Experienced	31	2.13	1.284		
C3	Less experienced	14	1.71	.994	.563	.457
	Experienced	31	2.19	1.108		
C4	Less experienced	14	1.86	.949	.009	.925
	Experienced	30	2.30	.988		
C5	Less experienced	4	2.25	1.500	1.165	.316
	Experienced	5	2.60	1.140		
C6	Less experienced	3	1.00	.000	4.820	.071
	Experienced	5	2.60	1.517		
C7	Less experienced	15	2.73	1.438	2.777	.103
	Experienced	30	2.33	1.241		
C8	Less experienced	14	2.93	1.639	.800	.376
	Experienced	31	3.61	1.358		
C9	Less experienced	4	1.25	.500	1.912	.204
	Experienced	6	3.67	.816		

C1=total quality management (TQM), C2=Last Planner System (LPS), C3=business process re-engineering (BPR), C4=concurrent engineering (CE), C5=just-in-time, C6=increased visualisation, C7=product cycles (PCs), C8=teamwork, C9=value-based management (VBM)

Barriers to implementation of lean construction in the Tanzanian construction industry

Table 6 presents a summary of respondents' views on barriers to implementation of lean construction in the Tanzanian construction industry. The results indicate that the respondents agree that all the listed challenges are hindering implementation of lean construction. Some of these challenges have been determined in work by Alinaitwe (2009), Matias and Cachadinha (2010), Bashir et al. (2015), and Mossman (2009). This implies that there are many barriers to implementation of lean construction in Tanzania, but that many more have not been explored, due to a low rate of implementation of lean

concepts. The study by Alinaitwe (2009) identifies the top 10 barriers that are easiest to overcome. Awareness of these barriers could facilitate implementation of lean construction in Tanzania.

Table 6: Barriers to implementation of lean construction

Challenge	N	Mean score	SD	Ranking
Lack of technical skills	45	2.53	.625	1
Inadequate design and client information	45	2.51	.727	2
Inadequate risk management	45	2.44	.693	3
Quality control of materials	45	2.36	.712	4
Lack of project team skills	45	2.22	.670	5
Waste in building projects	45	2.20	.815	6
Delays in delivery of materials	45	2.16	.737	7
Lack of communication within teams	45	2.13	.786	8
Corruption	45	2.11	.885	9
Business management skills	45	2.11	.682	10
Financial resources and equipment	45	2.09	.793	11
Work opportunities	44	2.05	.834	12
Lack of buildable designs	45	2.04	.767	13
Poor wages for professionals	45	2.02	.657	14

CONCLUSION AND RECOMMENDATIONS

Successful implementation of LC or any new innovative strategy requires a spirit of teamwork, and it needs to be supported by top management. Effective teamwork should aim to provide sufficient time and resources to develop an effective plan and manage changes arising from the implementation process. For example, in Tanzania, the majority of projects are delivered under traditional contractual procedures. This type of procurement advocates that design and implementation of design be treated as separate products, and this has led to poor design and client information (Marhani et al., 2013). In the course of undertaking construction activities, this tends to cause conflict between the two phases, and it creates much waste, which can be minimised by having a well-organised team. Furthermore, if the management of the organisation works as a team and learns technical skills from each other, this will obviously facilitate implementation and enforcement of LC.

The findings of this paper shed light on the state of adoption of lean construction concepts in the Tanzanian construction industry. There appear to be several barriers that hinder successful adoption of lean construction. It is necessary that these barriers be understood, so that organisations can determine what improvement efforts should be

taken, and what resources should be allocated. The findings of this study may be used by project participants, professionals, and organisations in the Tanzanian construction industry, so that they can change their mindset and set aside resources for implementing lean construction. Lean construction has a number of benefits for the construction industry. As such, it is of the utmost importance that its key concepts be adopted, so that the industry can make the most of lean construction.

Generally, there is a low rate of application of lean construction in Tanzania, as most of the listed lean construction concepts are not yet sufficiently recognised by the surveyed project participants and professionals. It was noted that teamwork is one lean concept that is used in Tanzania. Barriers to implementation of lean concepts are many, some of which are yet to be identified, but the main ones are lack of technical skills and poor design and client information. Use of teamwork would increase the level of collaboration among stakeholders, as well as awareness of lean concepts. Teamwork may also help some organisations to improve their implementation strategies. Through teamwork, the following could be realised: continuous training, and open communication channels between participants. A desire to "embrace lean" will be essential for future implementation of LC. Higher learning institutions offering construction-related programmes should consider including in their programmes an introduction to LC. The analysis and discussion of the findings presented in this paper provide the foundation for determining the state of adoption of lean in the Tanzanian construction industry. Further research is recommended to identify the factors that lead to successful implementation of lean construction, as well as organisation or implementation plans for smooth adoption of lean construction.

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