NIGERIAN CONSTRUCTION-RELATED PROFESSIONAL SERVICES FIRMS TO ADOPT LEAN CONSTRUCTION PRACTICES

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ABSTRACT

Studies have shown that construction projects are susceptible to problems such as low productivity, poor safety, inferior working conditions, insufficient quality, lack of timely communication and coordination amongst project stakeholders, and rising litigation. Adoption of lean construction (LC) principles within the manufacturing industry and other industries has led to notable improvement and resulted in improved time to market, reduced production costs, improved quality of the product, and active customer involvement. The study assessed the readiness of Nigerian construction-related professional services firms to adopt LC principles. The method of study involved a critical exposition of related literature, and use of the VERDICT readiness assessment model for analysis, and an ANOVA for readiness comparison. A structured questionnaire was issued for a sample size comprising 130 firms drawn from a finite population of 342 Nigerian construction-related professional services firms (project managers, architects, quantity surveyors, structural engineers, and M&E engineers) operating in Northern Nigeria. The findings of the study reveal that Nigerian construction-related professional services firms have process/project readiness to adopt LC principles, but that they do not have management, people and technology readiness to adopt LC principles. The study concludes that Nigerian construction-related professional services firms are not yet ready to adopt LC principles. The study recommends continuous awareness campaigns of LC principles and their potential benefits, via education and training to professional bodies, tertiary institutions offering construction-related programmes, and stakeholders in the construction industry.

Keywords: adoption, construction-related professional services firms, lean construction (LC), Nigerian construction industry, readiness

INTRODUCTION

Globally, the construction industry plays a key role in the economy of both developing and developed countries, contributing between 4% and 14% of the GDP, while generating a vast number of employment opportunities and wealth creation. However, until today, several countries are still facing a number of contingent problems, which should have been resolved. Koskela (2000) and LePatner et al. (2007) identify the problems that have been known to bedevil the construction industry as low productivity, poor safety, inferior working conditions, insufficient quality, lack of timely communication and coordination amongst project stakeholders, and rising litigation. The phenomenon of poor performance in construction has long been witnessed and recorded by academics and practitioners throughout the world, regardless of whether the country is developed, e.g. England (Eaton, 1994), or developing, e.g. Chile (Serpell et al., 1995). Thus, the UK government initiated reports, such as the Latham Report (Latham, 1994) and the Egan Report (Egan, 1998), both of which recommended the need for improvement of the construction industry's business performance.

The Nigerian construction industry is not immune to such problems, and it has been severely criticised for its inefficiency, low productivity, and lack of capacity to deliver and satisfy its clients. Oyewobi et al. (2011) attributed the drop in the Nigerian construction industry's contribution to GDP between 1980 and 2007 to poor performance and low productivity. Similarly, Idrus and Sodangi (2007) asserted that the Nigerian construction industry produces nearly 70% of the nation's fixed capital formation, yet its performance within the economy has been, and continues to be, very poor. Among the criticisms facing the industry are time and cost overruns (Kuroshi and Omorogbe, 2010; Ameh and Osegbo, 2011; Ogwueleka, 2011), inadequate planning and budgetary provisions, contract amount inflation, and inefficient and poor service delivery (Kolo and Ibrahim, 2010).

The need for greater coordination and integration within the industry has led to adoption of various concepts from other industries, such as partnering (Ibrahim and Price, 2006), concurrent engineering (Khalfan et al., 2001), technological innovations in design, and construction processes such as 3D, CAD, and modelling (Isikdag and Underwood, 2010; Olatunji et al., 2010; Abubakar, 2012). Lean construction principles are one of such innovative processes that bring about much-needed continuous improvement and desired change in the construction industry.

According to Dulaimi and Tanamas (2001), adoption of lean techniques in construction eliminates non-value steps, i.e. waste, it meets clients' demands better, and it dramatically improves architectural/engineering/construction (AEC) processes and products. Interestingly, unlike the case in Nigeria, lean techniques have been used with significant success in countries such as Singapore (Dulaimi and Tanamas, 2001), the UK (Common et al., 2000), Brazil (Da Silva and Cardoso, 1999), and Chile (Alarcón and Ashley, 1999). Thus, it is imperative for the Nigerian construction industry to exploit the widely acclaimed benefits of lean construction, in order to align its practice with global best practices, and to achieve the continuous improvement needed by its players in the industry.

However, because adoption of innovations such as lean construction principles usually brings about changes in the business processes and operational procedures of an industry or an organisation, there is a need to assess the level of readiness of the construction industry for lean construction implementation by

stakeholders' organisations, or by the entire construction industry, in order to continuously deliver value for money and effectively satisfy the needs of the client.

LITERATURE REVIEW

Lean construction principles

Lean construction has been defined in several ways by different authors. The most popular definition, by Koskela et al. (2002), states that 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. This approach is intended to cause developers, from the outset, to consider all aspects of the product life cycle, from conception through to disposal, including quality, cost, schedule, and user requirements. In the context of the construction industry, another definition states that lean construction is a holistic facility design and delivery philosophy, where the overarching aim is to maximise value to all stakeholders, through systematic, synergistic, and continuous improvements to contractual arrangements, product design, the construction process design and methods selection, the supply chain, and the workflow reliability of site operations (Abdelhamid, 2004).

Benefits of lean construction principles

Broadly speaking, lean construction has led to significant improvement in the performance of construction industry professionals, particularly in design, construction and facility management. Michigan State University (MSU) effectively benefits from lean construction twice – first as a client, and then on its own self-performed works – by saving on time and money, by improved quality of projects, by building relationships with service providers, and by providing value to end users, who otherwise are often not involved in the entire process. The following are some of the benefits of lean construction, as reported by Mossman (2009):

a. More satisfied clients;
b. Productivity gains;
c. Greater predictability;
d. Shorter construction periods;
e. Operatives are able to make better money;
f. Subcontractors are able to make better money;
g. Improved design;
h. Reduced costs, and less waste;
i. Improved safety and health, and
j. Improved quality, and fewer defects.

A case study conducted in the USA in 1998 shows remarkable benefits of implementing LC (Garnett, 1999): office construction times are reduced by 25% within 18 months, schematic design time is reduced from 11 weeks to 2 weeks, turnover is increased by 15% to 20% (Pacific Contracting), satisfied clients look to place repeat orders, and project costs are reduced.

Readiness assessment models

Readiness is a measure of the capability to adopt a new paradigm prior to its implementation. So many readiness assessment models have been developed in recent times for use in measuring readiness prior to adoption of a new paradigm.

Some of these tools include the one developed by Harvard University Center for International Development (CID, 2001), called the Networked Readiness Index, which gauges a country's ability to make use of its information and communication technology (ICT) resources. This index defines readiness as the degree to which a community is prepared to participate in the networked world, and its potential to be part of the networked world in the future (Kirkman et al., 2002). Similarly, the Asia-Pacific Economic Cooperation's (APEC) E-Commerce Readiness Assessment Guide focuses on government policies for e-commerce, while Mosaic's Global Diffusion of the Internet Project's readiness assessment tool aims to gauge and analyse worldwide growth of the Internet (Ruikar et al., 2006; Vaezi and Bimar, 2009).

While these tools are based on measuring readiness of countries, governments, and policies for adopting Internet technologies, there are other tools that focus on assessing readiness to adopt different engineering concepts and approaches. For example, SCALES (Supply Chain Assessment and Lean Evaluation System) was developed specifically for the manufacturing industry, in order to assess companies' (especially SMEs') readiness for adopting lean manufacturing techniques. There are several other tools that were developed for concurrent engineering (CE), such as RACE (Readiness Assessment for Concurrent Engineering), which was developed at West Virginia University in the United States in the early 1990s. RACE was conceptualised in terms of two major components: process, and technology. It is widely used in the software engineering, automotive and electronic industries (Ruikar et al., 2006). According to Khalfan and Anumba (2000), RACE can be modified to be used in construction and other industries. Similar to this tool is the SPICE (Standard Process Improvement for Concurrent Engineering) Questionnaire, which was developed at the University of Salford in the United Kingdom. It was designed to evaluate the key construction processes within construction organisations (SPICE Questionnaire, 1998). In addition, the BEACON (Benchmarking and Readiness Assessment for Concurrent Engineering in Construction) Model was created to evaluate the construction company's level of readiness for implementing concurrent engineering, with the aim of improving the project delivery process. Other tools include the Capability Maturity Model (CMM), developed for software development and evaluation, and the IQ Net Readiness Scorecard (Khalfan and Anumba, 2000; Ruikar et al., 2006; Aminali, 2007).

Another readiness assessment tool that is of particular relevance to this research is VERDICT (Verify End-user e-Readiness using a Diagnostic Tool), developed to assess the overall readiness of end users involved in the construction industry for using e-commerce technologies (Aziz and Salleh, 2011). The

VERDICT model is a combination of two e-readiness assessment models: the BEACON Model, and the IQ Net Readiness Scorecard. BEACON, as mentioned earlier, assesses the readiness of construction companies to improve their practices for implementing concurrent engineering. It consists of four elements: process, people, project, and technology. The IQ Net Readiness Scorecard is a web-based application developed by Cisco, based on a book called *Net ready*. Aminali (2007) assesses the readiness of IT service providers in such a way that the company is presented with statements that it has to judge, where the statements fall under four categories, namely leadership competency, governance competency, technological competency, and organisational competency. The average of the scores given will determine the company's e-readiness.

Similar methodology was adopted in developing the VERDICT model. In this model, the company is presented with statements that it has to judge, where the statements fall under four categories, namely management, process, people, and technology (Ruikar et al., 2006). The developers of VERDICT argued that to successfully implement any technology, there is a need to have people with adequate skills, understanding, and belief in the technology, then processes that enable and support successful adoption of the technology, then the technology tools and infrastructure necessary to support the business functions, and, lastly, consideration of management buy-in and belief. The next step is that management must believe in the technology and take strategic measures to drive its adoption, implementation, and use, in order to derive business benefits from the technology (Ruikar et al., 2006; Vaezi and Bimar, 2009). All the four elements have to work complementarily for any organisation to achieve readiness.

The developers claim that VERDICT can be used to assess the e-readiness of construction companies, departments within a company, or even working groups within a department. The assessment is performed by finding an average score for each of the four categories from the judgements of the respondents on the statements in the questionnaire. According to Ruikar et al. (2006):

- An average score greater than or equal to 0 and less than 2.5 shows a red colour, which indicates that urgent attention is needed to achieve e-readiness,
- An average score greater than or equal to 2.5 and less than 3.5 is an amber colour, which means that certain aspects need attention to achieve e-readiness, and
- An average score greater than 3.5 shows a green colour, which indicates that the organisation is adequately ready and mature enough for e-commerce tools.

The choice of these boundaries was based on simple average scores computed for each of the four elements in the questionnaire.

RESEARCH METHODOLOGY

The research methodology should clearly discuss the approach and/or the research design, data collection, and data analysis adapted or to be adapted in the research. One of the most important issues to be discussed here is the appropriateness of the

selected methodology, and whether it is the most appropriate choice compared to other alternatives. This is the opportunity for the authors to demonstrate their awareness and understanding (appropriate to the level of study) of the research tools commonly used in their field, and how this knowledge is used to inform them in constructing a robust methodology to tackle the research problems or questions.

This study made use of data and information collected with the aid of structured questionnaires which were administered in selected states in Northern Nigeria (specifically Kaduna and Kano states and Abuja (FCT)). In a study conducted by Dikko (2013), the total number of registered consulting firms with the Corporate Affairs Commission was shown to be 6,990, 34% of which are located in the northern part of the country. Making use of Yamane's (1967) sample size formula, i.e.

$$n = \frac{N}{1 + N(e)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

(1) where n = required sample size,

N = the population size, and

e = level of precision (0.050),

the sample size of the study was computed as 342.

The population for the study is construction-related professional services firms. They include project management firms, architectural design firms, structural design firms, mechanical and electrical engineering services design firms, and quantity surveying firms. The questionnaire was designed/structured based on the VERDICT readiness assessment model of Ruikar et al. (2006). Respondents were asked to select from responses on a five-point Likert rating scale (where 5 represents "strongly agree", and 1 represents "strongly disagree") the extent to which their firm conformed to the requirements of the VERDICT readiness assessment model. This was done to gain an objective indication of whether the findings identified in the literature review above are confirmed in practice.

A reliability analysis using the Cronbach's alpha was performed to determine the internal consistency, and thus the reliability, of the scale used in the survey questionnaire. The study utilised a number of descriptive statistical techniques to facilitate organisation, analysis and interpretation of the data. Means, standard deviations, and relative rankings were used.

FINDINGS AND DISCUSSION

Profile of the respondents

Of the 342 questionnaires administered, 130 (or 38%) of the total were returned and found appropriate for analysis. Moser and Kalton (1971) asserted that results of a survey can be considered reliable if the response rate is not lower than 30–40%. In view of this, the 38% response rate was considered adequate for purposes of analysis of the findings of the questionnaire. The purposive sampling method was adopted to ensure that only firms that are capable of providing the information required in the study were contacted.

Of the respondents, 27% were engaged in architectural design consultancy, 29% were engaged in quantity surveying consultancy, 21% were engaged in structural engineering consultancy, and 13% were engaged in project management consultancy. The remaining 10% of the respondents were engaged in mechanical and electrical engineering consultancy. The distribution of the respondents was representative of the major stakeholders in the industry. In terms of management level, 27% of the respondents belonged to the strategic/senior management level, 60% belonged to the middle management level, 8% belonged to the knowledge/lower management level, and 5% belonged to the operational level**.** In terms of work experience, 34% of the respondents had 16–20 years of experience, 24% had 11–15 years of experience, 22% had more than 20 years of experience, 15% had 6–10 years of experience, and 5% had less than 5 years of experience.

Assessment of the readiness of the various types of Nigerian construction-related professional services firms to adopt LC principles

Table 1: A summary of the average scores indicating the level of readiness of the various types of construction-related professional services firms

Professional services firms	Category	Average score	The situation, based on Ruikar et al.'s (2006) boundaries
Project management	Management	2.77	Amber
	Process/project	3.80	Green
	People	3.28	Amber
	Technology	3.18	Amber
Architectural design	Management	2.76	Amber
	Process/project	3.80	Green
	People	3.28	Amber
	Technology	3.23	Amber
Quantity surveying	Management	2.78	Amber

	Process/project	3.80	Green
	People	3.30	Amber
	Technology	3.26	Amber
Structural engineering	Management	2.77	Amber
	Process/project	3.84	Green
	People	3.28	Amber
	Technology	3.25	Amber
M&E engineering	Management	2.76	Amber
	Process/project	3.83	Green
	People	3.31	Amber
	Technology	3.27	Amber

(Source: Olamilokun et al., 2015)

The table presents average scores indicating the level of readiness of the various types of professional services firms in each category, i.e. management, process/project, people, and technology.

The average scores in all the categories except process/project were greater than 2.5 but less than 3.5 (amber) for all the various types of construction-related professional services firms considered in the study (project management, architectural design, quantity surveying, structural engineering, and M&E engineering firms in Nigeria). This clearly shows that project management firms, architectural design firms, quantity surveying firms, structural engineering firms, and M&E engineering firms in Nigeria all require attention on certain aspects to achieve management, people and technology readiness for adopting lean construction.

As shown in Table 1, for all the types of construction-related professional

services firms considered, process/project was the only category in which an average score greater than 3.5 (green) was obtained. This clearly indicates that project management firms, architectural design firms, quantity surveying firms, structural engineering firms, and M&E engineering construction-related professional services firms in Nigeria have adequate capability and maturity in this aspect, and that they are therefore ready to adopt new innovations.

The Cronbach's alpha computed to measure the internal consistency among the ratings of the respondents, as well as the reliability of the scales used for determining the readiness of construction-related professional services firms for adopting lean construction in the Nigerian construction industry, was very close to 1 (0.990), which indicates that the scales used were reliable, and that the respondents understood the questions that were presented to them in the questionnaire. The aforementioned findings corroborate the findings of Olatunji (2008), as they suggest that Nigerian construction-related professional services firms have a low level of awareness with regard to LC principles adoption.

Comparing readiness of the various types of Nigerian construction-related professional services firms to adopt LC principles

Table 2: Comparing readiness of the various types of Nigerian construction-related professional services firms to adopt LC principles

	Descriptive							
	n	Mean	SD	Std error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
Project management	4	3.258	0.424	0.212	2.583	3.932	2.77	3.80
Architectural design	4	3.268	0.425	0.213	2.591	3.944	2.76	3.80
Quantity surveying	4	3.285	0.417	0.208	2.622	3.948	2.78	3.80
Structural engineering	4	3.285	0.438	0.219	2.589	3.981	2.77	3.84
M&E engineering	4	3.293	0.437	0.219	2.597	3.988	2.76	3.83
Total	20	3.278	0.381	0.085	3.099	3.456	2.76	3.84
ANOVA								
	Sum of squares			df	Mean square		F	Sig.
Between groups	0.003			4	0.001		0.005	1.000
Within groups	2.750			15	0.183			
Total	2.753			19				

(Source: Olamilokun et al., 2015)

A one-way ANOVA was conducted to determine if there is a significant difference between the levels of readiness of the various types of Nigerian construction-related professional services firms to adopt lean construction, based on the following hypotheses:

Null hypothesis (H_0): There is no significant difference in the level of readiness of the various types of Nigerian construction-related professional services firms to adopt lean construction.

Alternative hypothesis (H_1): There is a significant difference in the level of readiness of the various types of Nigerian construction-related professional services firms to adopt lean construction.

As shown in Table 2, the significance value is above 0.05 (1.00), which indicates clearly that the null hypothesis, which states that there is no significant difference in the level of readiness of the various types of Nigerian construction-related professional services firms to adopt lean construction, is accepted.

CONCLUSION AND RECOMMENDATIONS

The paper assessed the readiness of Nigerian construction-related professional services firms to adopt LC principles. The VERDICT readiness assessment model developed by Ruikar et al. (2006) was adopted and used for the assessment. The findings of the study show that Nigerian construction-related professional services firms have process/project readiness to adopt lean construction principles, but that they need to give attention to management, people and technology readiness, in order to achieve full readiness to adopt lean construction principles.

This study therefore clearly provides the Nigerian construction industry with useful information on the nature of improvement needed to set the scene for effective implementation of LC principles, and thus improve performance and productivity in the industry. The study also provides a basis for further research on factors inhibiting Nigerian construction-related professional services firms from attaining management, people and technology readiness to adopt LC principles.

The study recommends integrating LC principles in the architecture, construction and engineering sector, and creating more awareness of LC principles and their potential benefits, via education and training to professional bodies, tertiary institutions offering any construction-related programmes, and stakeholders in the construction industry in general. Also, government authorities responsible for construction and urban development are advised to promote the use of LC principles, as a strategic approach towards achieving continuous improvement in construction.

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