AN APPRAISAL OF THE READINESS OF NIGERIAN BUILDING CONSULTING FIRMS TO ADOPT LEAN CONSTRUCTION PRINCIPLES

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OCTOBER, 2014

DECLARATION

I declare that the work in this thesis entitled "An Appraisal of the Readiness of Nigerian Building Consulting Firms to Adopt Lean Construction Principles" has been carried out by me in the Department of Quantity Surveying, under the supervision of Dr. A. D. Ibrahim and Dr. Y. M. Ibrahim.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree or diploma at any institution.

Olajide OLAMILOKUN (Signature) Date

CERTIFICATION

This thesis entitled "AN APPRAISAL OF THE READINESS OF NIGERIAN BUILDING CONSULTING FIRMS TO ADOPT LEAN CONSTRUCTION PRINCIPLES" by Olajide OLAMILOKUN meets the regulations governing the award of the degree of M.Sc. Project Management of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

Dr. A. D. Ibrahim		
Chairman, Supervisory Committee	(Signature)	Date
Dr. Y. M. Ibrahim		
Member, Supervisory Committee	(Signature)	Date
Dr. Y. M. Ibrahim		
Head of Department	(Signature)	Date
Prof. A. Z. Hassan		
Dean, School of Postgraduate Studies	(Signature)	Date

DEDICATION

I dedicate this work to Almighty God; the I am that I am, my Anchor in the storm, my Guide along the journey, the Light for every step, the Power behind me, the Spirit within me, the Staff that leads me on, all the applause is Yours.

To my siblings, Bisola, Mojisola and Olakunle OLAMILOKUN; my spouse, Oluwaseun Okeowo OLAMILOKUN and to those who see hope in this generation.

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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. The adoption of lean construction principles within the manufacturing and other industries had led to notable improvement and resulted in improved time-to-market, reduced production cost, improved quality of the product and active customer involvement. The study was aimed at appraising the readiness of Nigerian building consulting firms to adopt lean construction principles. The method of study involved a critical exposition of related literature and empirical study employing the mean scores and VERDICT readiness assessment model for analysis. A structured questionnaire was issued to a sample size comprising 130 firms drawn from a finite population of 360 Nigeria building consulting firms operating within Northern Nigeria. The result of the study revealed that the level of awareness of lean construction principles is increasing. Also, reduced cost and less waste were identified as the most important benefits of adopting lean construction principles; availability of trained professionals and education and skills development are the most important facilitators for adopting lean construction principles; inadequate exposure to requirements for lean implementation and inadequate preplanning are the most important barriers to adoption of lean construction principles in Nigeria construction industry. Nigeria building consulting firms has process/project readiness to adopt but do not have management, people and technology readiness to adopt lean construction principles. The study concludes that Nigeria building consulting firms are not yet ready to adopt lean construction Principles. The study recommends continuous awareness campaign of lean construction principles and its potential benefits via education and training to professional bodies, tertiary institutions offering any building construction related programmes and stakeholders in the construction industry.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Construction is a key sector of the national economy of nations contributing a big portion to their total employment and revenue generation. The problems facing construction are well documented such as low productivity, poor safety, inferior working conditions, insufficient quality, lack of timely communication and coordination amongst project stakeholders and rising litigation (Koskela, 2000 and LePatner, 2007). The UK Government initiated reports such as the Latham Report (1994) and the Egan Report (1998), both of which recommended the improvement of the construction industry's business performance.

The Nigerian construction industry suffers from all the above mentioned problems. It has severally been characterized as inefficient with 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 low. Other criticisms facing the industry are time and cost overruns (Kuroshi and Okoli, 2010; Ameh and Osegbo, 2011; Ogwueleka 2011), inadequate planning and budgetary provisions, contract sums inflation, inefficient and poor service delivery (Kolo and Ibrahim, 2010).

Aibinu and Jagboro (2002); Oyewobi *et al.* (2011); Idiake and Bala (2012) emphasised the need for improved performance and efficiency if the industry is to deliver value for money and

effectively satisfy the needs of the clients. However, there are several responses to these calls for flattened organisation structures, the elimination of waste, teamwork, efficient use of resources and co-operative supply chain management, continuous improvement in efficiency and productivity of the Nigerian and the global construction industry from different perspectives.

The need for greater co-ordination and integration within the industry has led to the adoption of various concepts from other industries, for example; partnering (Ibrahim and Price, 2006), concurrent engineering (Khalfan *et al.,* 2000), technological innovations in design and construction processes such as 3D, CAD and modelling (Isikdag and Underwood, 2010; Olatunji, *et al*., 2010); BIM (Abubakar, 2012) and Lean Construction (LC) (Ballard and Howell, 2003).

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 to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through 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 with an overarching aim of maximizing value to all stakeholders through systematic, synergistic, and continuous improvements in the contractual arrangements, the product design, the construction process design and methods selection, the supply chain, and the workflow reliability of site operations (Abdelhamid, 2004).

In order to introduce aspects of lean construction in the construction project delivery process, various researches reported that lean Construction Principles have recently received attention as

a modern way to improve construction performance and labour productivity (Abdel-Razek *et al*., 2007; Idiake and Bala, 2012), including continuous improvement, flattened organisation structures, the elimination of waste, teamwork, efficient use of resources and co-operative supply chain management (Womack and Jones, 1996).

It is critical to note that while lean construction is identical to lean production in spirit, it is different in how it was conceived as well as how it is practiced. Implementing lean construction has its benefits reaped by not only contractors, a popular misconception, but the architect and owner as well, who are set to gain a lot by this practice. Sutter Health, a California healthcare provider, has requested that its contractors use a lean construction approach in their 2004-2012 $6 billion dollar construction program. Sutter Health states that their first lean construction project alone saved $100,000 from the planned budget and 60 days of scheduled time (ENR 2007). Contractors like Turner and DPR Construction, who are working with Sutter Health, others like Walbridge Aldinger, Boldt Construction, and Messer Construction have also reported benefits of implementing lean construction. Michigan State University (MSU) can reap the double benefits of lean construction as a client and on its own self-performed works, by saving on time and money and improved quality of projects, building relationships with the service providers, and providing value to the end users who otherwise are often not involved in the entire process.

A typical case study taken in USA in 1998 shows remarkable benefits of implementing lean construction (Garnett *et al*., 1999): office construction times reduces by 25% within 18 months; Schematic design time reduces from 11 weeks to 2 weeks; turnover increases of 15-20% (Pacific Contracting); satisfied clients looking to place repeat orders; reduction of project costs.

Dulaimi and Tanamas (2001) reported that the adoption of lean techniques to construction eliminates non-value steps i.e. waste and better meet client's demands and dramatically improves the Architectural/ Engineering/ Construction (AEC) process and products. Interestingly, unlike Nigeria, this has been used with significant benefits in countries like Singapore (Dulaimi and Tanamas, 2001); UK (Common *et al*. 2000); Brazil (Silva and Cardoso, 1999); Chile (Alarcon and Ashley, 1999) and so on. Consequently, it becomes imperative for the Nigerian construction industry, which has been described as a 'sleeping giant' and having no capacity to deliver due to inefficiency and poor service delivery among other problems (Kolo and Ibrahim, 2010), to exploit the widely acclaimed benefits of lean construction in order to practise in line with the global best practices and achieve the continuous improvement needed by its players in the industry.

Researchers concluded that much more needs to be done if the reported benefits of lean construction in other industries such as manufacturing can be realized in construction industry. It is also concluded that an important aspect of lean construction implementation in the Nigeria construction industry especially in the Nigerian building consulting firms, which is often overlooked, there is the need to carry out a readiness assessment of the construction industry for lean construction implementation.

Various definitions of readiness could be found from literature on the subject. The first efforts in defining readiness were undertaken by the Computer Systems Policy Project (CSPP) in 1998, in which readiness was defined with respect to a community that had high-speed access in a competitive market; with constant access and application of it in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favourable to promote connectedness and use of the network (Beig *et al.*,

2007). Dada (2006) on the other hand, defined readiness as "the measure of the degree to which a country, nation or economy may be ready, willing or prepared to obtain benefits that arise from information and communication technologies (ICT)".

From the above definitions, it is obvious that there is no specific definition for the concept of readiness because it depends on various contexts, different situations and different users. Generally, the term readiness is to measure the capability to adopt new paradigm such as lean construction prior to its implementation. Prior to adoption of new paradigm, readiness assessment was also conducted for Concurrent Engineering (Khalfan *et al.*, 2000), Automation and Engineering industries (Ruikar *et al.*, 2006), Building Information Modelling (Abubakar, 2012). According to Khalfan *et al*., (2001) to improve implementation planning, is to conduct readiness assessment for an organisation to investigate the level at which the organisation is ready to adopt new paradigm.

However, adoption of innovations such as lean construction usually brings about changes in the business processes and operational procedures of an industry or an organisation. It may also be faced with some risks and challenges that may hinder its successful take-up. It is therefore important to evaluate the level of readiness, facilitators and impediments of adopting Lean Construction in construction organisations or the entire construction industry.

1.2 Problem Statement

Aibinu and Jagboro (2002); Oyewobi *et al.* (2011); Idiake and Bala (2012) emphasised the need for improved performance and efficiency if the industry is to deliver value for money and effectively satisfy the needs of the clients.

Several studies have reported how Lean Construction has contributed to performance improvements and achieving value for the client's money in the construction industries of several countries e.g. One case study taken in USA in 1998 shows remarkable benefits of implementing lean construction (Garnett et al., 1999): office construction times reduces by 25% within 18 months; schematic design time reduces from 11 weeks to 2 weeks; turnover increases of 15-20% (Pacific Contracting); satisfied clients looking to place repeat orders; reduction of project costs.

However, despite the potential benefits of lean construction and assuming its awareness among stakeholders little has been reported regarding its implementation for performance improvement and effective satisfaction of client's needs by Nigerian building consulting firms. It is also not clear whether or not the consulting firms are ready to adopt it. A gap in knowledge therefore exists with regards to the current state of the Nigerian consulting firms towards adopting lean construction principles.

1.3 Need for the Study

There has been a great concern on the need for the Nigerian construction industry to improve on its performance and deliver projects efficiently. Lean construction readiness assessment is used to improve lean construction implementation. It is conducted before the introduction of lean construction within an organisation, and investigates the extent to which the organisation is ready to adopt lean construction. While this has been carried out in other industry sectors, it is normal for such assessments to be undertaken in construction industry.

The outcome of this research is expected to provide such information and set the scene for effective lean construction implementation in the construction industry. This will go a long way

in improving project performance towards satisfying clients' needs in the Nigerian construction industry as witnessed in other parts of the world where lean construction is being practised.

1.4 Research Aim and Objectives of the Study

1.4.1 Aim

The aim of this study is to appraise the level of organisational readiness of Nigerian building consulting firms towards adopting lean construction principles with a view to improving project performance towards satisfying of clients' needs.

1.4.2 Objectives

i. To articulate the steps necessary for adopting the lean construction concept.
ii. To establish the level of awareness of lean construction within the Nigerian building consulting firms.
iii. To assess the facilitators and barriers that affects the adoption of lean construction principles.
iv. To investigate the level of organisational readiness of Nigerian building consulting firms towards adopting lean construction principles.

1.5 Scope and Limitations

1.5.1 Scope

This research considers the Nigerian construction industry with reference to the members of a typical building design team, which includes; project managers, architects, structural engineers mechanical and electrical services engineers, and quantity surveyors. The areas covered were Abuja, Kaduna and Kano state.

1.5.2. Limitations

1. The result of this study is limited by the accuracy of the responses provided by the respondents.
2. The study only considered building consulting firms, the result of this study therefore does not reflect the readiness level of contracting firms.

CHAPTER TWO

LITERATURE REVIEW

2.1 Lean Construction

The lean production philosophy that had contributed to the manufacturing industry took the attention of the people in the construction industry as well. This is accomplished by changing the focus of management from optimizing separate technologies, assets and vertical departments to optimizing the flow of products and services through the entire value stream that flow horizontally across technologies, assets and departments to the customer. Especially, since the early 1990s, a "lean construction" concept has been tried to be created and promoted by means of institutes, governmental reports, construction management scholars, some occupational organizations and so on. The most notable of the organizations that have been working solely for the development of the lean thinking in the construction industry are the Lean Construction Institute (L.C.I.) of the U.S. and the International Group for Lean Construction (I.G.L.C.). Louri Koskela was the first to introduce the lean movement in manufacturing to the construction industry. He hosted the first conference of the I. G. C. L. in Espoo, Finland in 1993. A group of researchers at the conference adopted the name "lean construction".

The lean construction efforts are aimed at contributing to the construction industry via the lean motives and methodologies. Ballard and Howell (2003) explained the theoretical background of lean construction as follows: "we understand projects to be temporary production systems linked to multiple, enduring production systems from which the project is supplied materials, information and resources."

Koskela (2000), underlining the fundamental goals of a production system as maximizing value, minimizing waste and delivering the product, explained the framework in which a production system is applied to construction. The goal is taking the basic lean motives such as elimination of waste, cycle time reduction, variability reduction, pull–driven production control, continuous flow and continuous improvement as pivotal points and developing methodologies and applications in the context of construction. Continuous improvement is used to prevent the same mistake repeating. Waste is eliminated by designing processes so they need less human effort, less space, capital and time, for less cost and with fewer defects.

Dulaimi and Tanamas (2001) the adoption of lean techniques to construction eliminates non-value steps i.e. waste and better meet client's demands and dramatically improves the Architectural/ Engineering/ Construction (AEC) process and products with significant benefits in countries like Singapore (Dulaimi and Tanamas, 2001), UK (Common *et. al*., 2000), Brazil (Silva and Cardoso, 1999), Chile (Alarcon and Ashley, 1999) and so on. Thus, adopting lean practices demands behavioral change amongst all participants, from top-level management to bottom-level worker; this can be achieved by both regularly practicing lean and orienting new participants through discussions. Michigan State University reap the double benefits of lean construction as a client and on its own self-performed works, by saving on time and money and improved quality of projects, building relationships with the service providers and providing value to the end users who otherwise are often not involved in the entire process.

Lean in construction offers valuable and important capabilities including continuous improvement, flattened organisation structures, the elimination of waste, teamwork, efficient use of resources and co-operative supply chain management. According to Dulaimi and Tanamas (2001), the application of lean techniques to construction eliminates non-value steps i.e. waste and it better meets

client's demands and dramatically improves the Architectural/ Engineering/ Construction (AEC) process and products.

2.2 Definitions of Lean Construction

Ever since the introduction of lean construction, the international academic lean construction circle has been developing theory and applications, i.e. International Group for Lean Construction (IGLC 2006), Lean Construction Institute (LCI 2006), and Lean Construction Journal (LCJ 2006), which have helped change and improve how production in construction is managed and executed. The same development trend is also evident in other countries.

There is a strong belief in these sources that the Lean philosophy can act as a mechanism to reduce wasteful activities by improving the management of construction. Thus, lean construction has been defined in many ways by many researchers and organisations. There exists serious argument among practitioners and scholars as regards the definition of lean construction. Koskela *et al.* (2002); Kim (2002); Ballard and Howell (2004); Abdelhamid (2004); Mossman (2009) and NASFA *et al.* (2010) examined the different views of scholars in this regard. Some experts consider lean construction techniques as a new paradigm challenging traditional thinking about construction and project management. The table below shows some of the definitions given by experts.

Table 2.1 Definitions of Lean Construction

AUTHOR	DEFINITION
Kim (2002)	Lean construction can be defined over a new production management based project delivery system that challenges the trade-off between time, cost and quality.

Koskela *et al*. (2002)	Lean construction is a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value.
Ballard and Howell (2004)	Lean construction is a new paradigm challenging traditional thinking about construction and project management.
Abdelhamid (2004)	Lean construction is a holistic facility design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic, and continuous improvements in the contractual arrangements, the product design, the construction process design and methods selection, the supply chain, and the workflow reliability of site operations.
Mossman (2009)	Lean construction is a production management-based project delivery system emphasizing the reliable and speedy delivery of value. The ultimate goal is carry on the project while maximizing value, minimizing waste and pursuing perfection – for the benefit of all project stakeholders.
NASFA *et al*. (2010)	Lean construction is commonly thought of being the continuous process of eliminating waste, meeting all customer requirements, focusing on the entire value stream, and pursuing perfection in the execution of a constructed project.

2.3 Necessity of Lean Construction

The need for continuous improvement to the conventional design and construction in the industry has been well documented in the literature. Several studies and government reports have enunciated the desire for the construction industry to improve and change the way it performs its primary activities (Ibrahim and Price, 2006).

The traditional system of construction project focuses more on keeping track of time and cost. Time control is about looking at the progress in the production line, while cost control is primarily concerned with the budget. Cost control tracks if the project is under or over budget. Kim (2002) suggests that in traditional construction, control consists on monitoring against schedule and budget estimates; while in lean construction control is defined as causing events to conform to plan. Kim (2002) continues on to say that traditional construction focuses more on individual activities. In traditional construction, control begins with tracking cost and schedule, and therefore any effort to improve productivity lead to unreliable work flow due to sub-optimization. As a result, project performance is considerably reduced.

In Lean philosophy, the focus is on how one activity affects the next activity, as all activities are part of the whole system. Ballard and Howell (1998) claimed that the goal in lean construction is to improve the performance of the whole system. They put forward that where current project management manages projects as more or less independent activities, Lean philosophy works first to assure the reliable flow of work between the tasks. In that perspective, Koskela (2000) depicts construction as a continuous flow of materials and/or information instead of just conversion activities (from input to output). Also states that it is crucial that the peculiarities of construction are understood and taken into consideration in construction management both from

the point of view of Transformation-Flow and Value concept to foster tremendous improvement in construction industry.

Lean construction initiative proposes a combined perception and application of conversion, flow and value managements (sometimes referred as T.F.V. theory) instead of a solely conversion oriented management. The ultimate goal is to create value for customers. One important question about these views is how they will apply simultaneously in order to execute a construction project. Bertelsen and Koskela (2002) summarized the combined application approach as follows:

- Integration: In each managerial situation, all three views must be acknowledged.
- Balance: In case of contradictory principles, a balance should be sought.
- Synergy: The synergy between the three views should be utilized.
- Contingency: All views have not necessarily the same weight in each situation, depending on conditions, the critical view for success should be predicted.

The most fundamental difference between traditional and lean construction can be found in scheduling (Kim 2002). In scheduling, lean construction uses the "pull" work schedule while traditional construction uses the "push" work schedule. Pull systems schedule work based on demand as opposed to the push systems which schedule work based on system status.

Salem *et al*. (2006) argue that to fully and effectively apply lean principles in construction, the focus must be on the whole construction process. All stakeholders must be committed, involved and work together to overcome obstacles. Lean construction principles are as follows: Eliminate waste, Specification of value from the perspective of end user or customer, Identification of the process delivering what the customer values (the value stream) and eliminating all non-value adding steps, Make the remaining value adding steps flow without interruption by managing the

interfaces between different steps, Let the customer pull–do not make anything until it is needed, then make it quickly and pursue perfection by continuous improvement.

Dulaimi and Tanamas (2001) explain that the adoption of lean techniques to construction eliminates non-value steps i.e. waste and it better meets client's demands and dramatically improves the Architectural/Engineering/Construction (AEC) process and products. Interestingly, unlike Nigeria, this has been used with significant benefits in countries like Singapore (Dulaimi and Tanamas, 2001); UK (Common *et. al.,* 2000); Brazil (Silva and Cardoso, 1999); Chile (Alarcon and Ashley, 1999) and so on.

2.4 Benefits of Lean Construction

Broadly speaking, lean construction has led to a significant improvement in the performance of construction industry professionals especially in design, construction and facility management. Michigan State University (MSU) reap double benefits of lean construction as a client and on its own self-performed works, by saving on time and money and improved quality of projects, building relationships with the service providers, and providing value to the 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 able to make better money.

f. Sub-contractors able to make better money.

g. Improved design.

h. Reduced costs, less waste.

i. Improved safety and health.

j. Improved quality, fewer defects.

One case study taken in USA in 1998 shows remarkable benefits of implementing LC (Garnett *et al*., 1999): Office construction times reduces by 25% within 18 months; Schematic design reduces from 11 weeks to 2 weeks; Turnover increases of 15-20% (Pacific Contracting); Satisfied clients looking to place repeat orders; Reduction of project costs.

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Lean construction is a production management-based approach to project delivery. It refers to the application and adoption of the underlying concepts and principles of the Toyota Production System to construction. This approach changes the whole construction process. The design and delivery process are designed together, and the line between them fades. At the project delivery phase, work is structured throughout the process aiming at maximizing value and reducing

waste. Total project performance is improved and managed, because it is more important than reducing cost and increasing the speed of any activity. The performance is what is emphasised, measured and improved. By making specialists in design, supply and assembly work closely together, value is delivered to the customer and waste is reduced. To ensure continuous improvement, the team's capabilities must be best used to develop both individual and joint contributions.

2.5 Barriers and Drivers of Lean Construction Adoption

2.5.1 Drivers of lean construction adoption

According to Salem *et al.* (2006) lean construction is seen as an enabler/driver that can help the building industry to improve its productivity by ensuring effective communication and collaboration between all project stakeholders from inception to completion of building projects. Several lean construction related studies have been reported, especially those that have to do with its success stories and inherent benefits. There are numerous case studies (Garnett et al., (1999); Dulaimi and Tanamas (2001); ENR (2007) and Mossman (2009) that provide evidences to support the fact that the use of Lean Construction makes the building process more efficient and effective. However, drivers/facilitators identified in several studies and a thorough review of research by Alarcon *et al.* (2002); Castka *et al.* (2004); Olatunji (2008); Alinaitwe (2009); Abdullah *et al.* (2009) and Mossman (2009) found Top Management support and commitment, Education and skills development, Client interest in the use of lean construction in their project, Commitment and cooperation of professional bodies, Attitudinal change, Government policy and Availability of trained professionals are among the facilitators to adopt lean construction principles across organisations.

2.5.2 Barriers of lean construction adoption

The introduction and adoption of any new techniques such as lean construction usually requires that the factors that may positively or negatively affect the adoption by the relevant stakeholders be identified and addressed for the successful take up of the innovations and subsequent benefits to be derived. Several researches have been conducted in various countries to identified factors that could affect the successful implementation of lean construction. Abubakar *et al*. (2010) classified these barriers into six different categories such as financial, educational, governmental, attitudinal, managerial and technical issues, categories based on a thorough and critical review of international literature relating to the take up of lean practice.

A. Management issues

The top management of every organisation has a major role to play in achieving a successful implementation of innovative strategies (Salem *et al.*, 2005; Hudson, 2007). The success of lean practice lies in their commitment in developing and implementing an effective plan and adequately providing the required resources and support to manage changes arising from the implementation. However, barriers identified in several studies seem to be related to management issues. A thorough review of research by (Common *et al*. (2000); Alarcon *et al.* (2002); Forbes and Ahmed (2004); Olatunji (2008) and Alinaitwe (2009)) found delay in decision making, lack of top management support and commitment, poor project definition, delay in materials delivery, lack of equipment, materials scarcity, lack of time for innovation, unsuitable organisational structure, weak administration, lack of supply chain integration, poor communication, use of substandard components, lack of steady/work engagement, long implementation period, inadequate preplanning, poor procurement selection strategies, poor planning, inadequate resources, lack of client and supplier involvement, lack of customer focus

and absence of long term planning are among major barriers to lean practice. Though some appear easy to be addressed, the overcoming of these barriers is very critical to the implementation of lean construction across organisations.

B. Financial issues

The implementation of innovative strategies like lean construction requires some funds. Adequate funding is needed to motivate the workers, provide relevant equipments and employ lean specialist to guide both employers and employees in implementing the concept. Financially related issues are among the most common barriers to lean practice across different organisations in various countries. However, the nature of this barrier varies across countries. An analysis of studies reported by Common *et al.* (2000); Olatunji (2008) and Mossman (2009) identified some of these barriers to include corruption, inadequate projects' funding, inflation, implementation cost, poor professional wages, lack of incentives and motivation, and risk aversion. Unless adequate efforts are made to overcome these barriers, several companies could be discouraged from implementing lean in their organisations.

C. Educational issues

There have been several efforts to provide awareness, guidance and knowledge relating to lean construction by academics, researchers, practitioners and bodies such as Lean construction institutes, Construction Lean Implementation Programme (CLIP), Construction Excellence (CE) and British Research Establishment (BRE). However, these bodies operate in very few countries. Despite the large amount of publications made by researchers, it seems educational issues appear to be the most common barriers to lean practice. This may be related to the fact that the concept was adopted from the manufacturing industry. Some of these barriers are identified by Common

et al. (2000); Cua *et al.* (2001); Alarcon *et al*. (2002); Castka *et al.* (2004); Olatunji (2008); Alinaitwe (2009); Abdullah *et al*. (2009) and Mossman (2009) to include lack of understanding, lack of technical skills, high-level illiteracy, lack of training, lack of holistic implementation, inadequate knowledge, lack project team skills, inadequate exposure to requirements for lean implementation, lack of awareness programmes, difficulty in understanding concepts and lack of information sharing. Hence, it can be suggested that educational barriers pose a great threat to the sustainability of lean practice.

D. Governmental issues

Despite the significant economic contribution made by the construction sector in various countries, it faces numerous problems which appear to be related to government policies. Some studies reveal that certain barriers arose due to government attitudes towards the construction industry in some countries. An in-depth analysis of research findings in Olatunji (2008) and Alinaitwe (2009) reveals barriers like government bureaucracy, inconsistency in policies, lack of social amenities and infrastructure, materials unavailability and unsteady price commodities. Furthermore, some of the financial barriers like inflation, professional wages, and corruption practices could also be related to government issues.

E. Technical issues

The implementation of lean construction may be affected by barriers which are technical. These barriers are considered technical because they have a direct impact on applying certain lean construction principles and tools such as reliability, simplicity, flexibility and benchmarking (Koskela 1992). Some of these were identified by Ballard and Howell (1998), Koskela (1999) and Alinaitwe (2009) as lack of buildable designs, incomplete designs, poor performance measurement strategies, lack of agreed implementation methodology, lack of prefabrication,

uncertainty in supply chain, lack of design constructability, inaccurate and incomplete designs. Furthermore, Mossman (2009) also identified the fragmented nature of industry as a barrier to teamwork and collaborative partnering. Though these issues relate to certain tools, they could hinder a holistic implementation of the concept. A haphazard implementation may not yield the full benefits of lean construction.

F. Human attitudinal issues

According to Howell (1999), human attitude is one of the major factors affecting the implementation of lean construction in various construction industries. Based on Studies carried out by Common *et al*. (2000); Cua *et al.* (2001); Alarcon *et al*. (2002); Castka *et al*. (2004); Forbes and Ahmed (2004); Alinaitwe (2009) and Mossman (2009), some of these factors are lack of transparency, cultural change, lack of team spirit, lack of self-criticism, lack of teamwork, lack of cooperation, poor housekeeping, poor leadership, leadership conflict, poor understanding of client's brief, misconceptions about lean practice, over enthusiasms, seen as too complex and alien, and fear of unfamiliar practices.

A change is necessary for construction companies to continuously meet clients' needs and respond to the global, social and environmental challenges. Companies must take advantage of research and technological developments to continually improve efficiency and quality of products and services so as to withstand existing and future market competitions (Paton and James 2008). However, for a change to be effective, its implementation has to be well managed.

A sustainable change requires building trust and establishing a new culture of constant learning, improvement and perfection among employers and employees. A Lean Construction expert can be consulted to create awareness among clients, contractors, subcontractors, suppliers and consultants on the aims, objectives, goals and benefits of Lean Construction and its advantages

over traditional management approach. The extent and mode of applying lean techniques should be discussed to clear misconceptions and misunderstandings.

2.6 Readiness Assessment Models

Various definition of readiness could be found from literature on the subject. The first efforts in defining readiness were undertaken by the Computer Systems Policy Project (CSPP) in 1998, in which readiness was defined with respect to a community that had high-speed access in a competitive market; with constant access and application of ITs in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favourable to promote connectedness and use of the network (Beig *et al.,* 2007). Dada (2006) on the other hand, defined readiness as "the measure of the degree to which a country, nation or economy may be ready, willing or prepared to obtain benefits that arise from information and communication technologies (ICT)".

From the above listed definitions, it is obvious that there is no specific definition for the concept of readiness because it depends on various contexts, different situations and different users. Generally, the term readiness is to measure the capability to adopt new paradigm such as lean construction prior to its implementation. Prior to adoption of a new paradigm**, s**o many readiness assessment models have been developed in recent times. According to Ruikar *et al.* (2006), each tool gauges how ready a society or economy is to benefit from Information Technology (IT) and e-commerce. Vaezi and Bimar (2009) observed that the range of tools use widely varying definitions for e-readiness and different methods of measurement. Aziz and Salleh (2001) also asserted that there is no specific definition for the concept of readiness. Some tools assess the readiness of countries and economies to implement internet technologies on a global platform,

while others are more focused on measuring the readiness of specific sectors to adopt the technologies.

Some of those tools include the one developed by Harvard University Center for International Development (CID 2001) called 'Networked Readiness Index' which gauges a country's ability to make use of its Information and Communication Technology (ICT) resources. It defined 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-readiness assessment focused on government policies for e-commerce, while Mosaic global diffusion of the internet project's readiness assessment tool aimed at gauging and analysing the worldwide growth of the internet (Ruikar *et al*., 2006) and (Vaezi and Bimar, 2009).

On the other hand, as these tools were based on measuring the readiness of countries, governments and policies for adopting internet technologies, there are others that focused on assessing the 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. Furthermore, there are several other tools that were developed for Concurrent Engineering (CE) such as RACE (Readiness Assessment for Concurrent Engineering) which was developed in the West Virginia University (United States) in the early 90s. It 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 one is the SPICE (Standard Process

Improvement for Concurrent Engineering), which was developed in the University of Salford, United Kingdom in a form of a questionnaire. It was designed to evaluate the key construction processes within construction organisations (SPICE Questionnaire, 1998). In addition, the BEACON (Benchmarking and Readiness Assessment Model for Concurrent Engineering) was created to evaluate the construction companies' readiness level in implementing concurrent engineering with the aim of improving the project delivery process. Others 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) and (Aminali, 2007).

Another readiness assessment tool that is of particular relevance to this research is the VERDICT (Verify End-User e-Readiness using 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 its practices for implementing concurrent engineering. It consists of four elements- process, people, project and technology. IQ Net readiness scorecard is 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 companies are presented with statements which fall into four categories as leadership, governance, technology and organisational competencies, for which, upon completion, they will be shown their e-readiness assessment result.

Similar methodology was adopted in developing the VERDICT model. In it, companies' e-readiness results are presented to them after responding to some statements that fall under four categories- management, process, people and technology. Ruikar *et al.* (2006) the developers of

VERDICT argued that to successfully implement any technology, there is need to have the people with adequate skills, understanding of, and belief in the technology, then processes that enable and support the successful adoption of the technology, then the technology tools and infrastructure necessary to support the business functions and another key element to consider is the management buy-in and belief. Therefore, the next is the management that believes in the technology and takes strategic measures to drive its adoption, implementation and usage in order to derive business benefits from the technology (Ruikar *et al.,* 2006) and (Vaezi and Bimar, 2009). All the four elements have to work complementarily for any organisation to achieve e-readiness. The model is different from the BEACON and the IQ Net readiness scorecard in that it directly addresses the construction sector end-users in evaluating their e-readiness for using e-commerce technologies such as web based collaboration while the former two are concerned with the readiness of technology companies such as software companies or vendors.

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 judgment of the respondents on the statements of the questionnaire. According to Ruikar *et al.* (2006);

- An average score greater than or equal to zero and less than 2.5 shows a red colour which indicates that urgent attention is needed for to achieve e-readiness.
- An average score greater than or equal to 2.5 and less than 3.5 is amber colour which means that certain aspects need attention to achieve e-readiness.

- An average score greater than 3.5 shows a green colour which indicates that the organisation is adequately ready and matured 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.

CHAPTER THREE

RESEARCH METHOD

3.1 Introduction

The effect of research method on the possible outcome of any research endeavour can never be overemphasized. This chapter discusses the research design and methodology employed in this study, including the rationale for the research design and procedure used.

A quantitative research approach was adopted for this study. This involved the use of a self-administered questionnaire survey as the instrument/tool for data collection. As defined by Aliaga and Gunderson (2000), a quantitative research approach involves explaining phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics). For the purpose of this study, the concept of lean construction was the phenomena being explained, while the use of a self-administered questionnaire survey enabled the conversion of lean construction principles which do not naturally exist in quantitative form, into quantitative data that was then analysed using mathematically based methods.

3.2 The Questionnaire Survey

3.2.1 Study population

Building consulting firms in three major states of Nigeria (namely; Abuja (FCT), Kaduna and Kano states of Nigeria), were chosen as the target population for this study. Building consulting firms were chosen on the basis that; as a major party responsible for the implementation of lean construction in the Nigerian construction industry, obtaining details with regards to their way of practising the concept will provide a clear indication of how ready the Nigeria construction

industry is to adopt the concept. Similarly, Abuja (FCT), Kaduna and Kano states of Nigeria were chosen on the basis that; they are developed states with a large concentration of building consulting firms.

In a study conducted by Kado (2013), the total number of registered design firms with the Corporate Affairs Commission was shown to be 6,990; 34% of which are located in northern part of the country.

3.2.2 Sampling frame and sample size

Since all the building consulting firms cannot be studied, a sample of the population was focused on. The study identified the following groups of firms as those responsible for design of buildings in Nigeria. They include; Project Management Firms, Architectural Design Firms, Structural Design Firms, Mechanical and Electrical Services Design Firms, and Quantity Surveying Firms.

Making use of Yamane (1986)'s formula for calculating sample size i.e.;

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

Where;

n = required sample size

N = the population size

e = level of precision (0.050),

The sample size for this study was calculated to be 342. Taking into consideration, the likelihood that not all building consulting firms will be experienced enough to provide reliable answers to the questions raised in the survey questionnaire. A purposive sampling survey was used to select the building consulting firms who were issued with questionnaires through mails. A survey

package comprising of a covering letter, survey instructions and a few separate sets of self-administered questionnaires and stamped self-addressed return envelopes was mailed to selected building consulting firms whose full addresses were known. Other selected building consulting firms whose full addresses were not known, were located at their project sites and issued with the questionnaire.

In order to make sure the responses to the questionnaires will be equal to the sample size computed for this study, a total of 360 questionnaires were issued out, instead of 342. However, after several follow-ups and reminders, only 130 questionnaires were completed and returned. The number of questionnaires completed and returned (130) was far much lower than the sample size computed for the study (342). However, going by Moser and Kalton (1971)'s assertion that the result of a survey could be considered as biased and of little significance if the return rate was lower than 30-40%, the number of questionnaires completed and returned were therefore considered adequate for analysis, as 130 represents 36% of the total questionnaires administered (360).

3.2.3 Structure of the questionnaire

The questionnaire was designed to elicit information relating to the practice of lean construction in the Nigerian construction industry. Particularly, the information requested for included; the level of existence of vital conditions which will facilitate the practice of lean construction by consulting firms, the level of awareness of consulting firms to the potential benefits of lean construction, as well as the barriers to adopting lean construction.

Two sections were created in the questionnaire; the first section requested for demographic information about the respondent, which will aid in determining how reliable/qualified a respondent was to have filled the questionnaire. The second section comprised four parts (A, B,

C and D), each of which were structured using information derived from a critical review of existing literature. The format of the VERDICT e-readiness questionnaire outlined by Ruikar *et al.* (2006) was adopted for all four parts. Respondents were therefore requested to indicate their extent of agreement using a scale of 1 to 5, where 1 represented "strongly agree" and 5 represented 'strongly disagree". In the first part (part A), respondents were requested to indicate their extent of agreement with a given list of facilitators for adopting lean construction. In part B, respondents were requested to indicate their extent of agreement with a given list of potential benefits of adopting lean construction in the Nigerian construction industry. Similarly, in part C, respondents were requested to give their extent of agreement with a given list of barriers to adopting lean construction in the Nigerian construction industry. In the last part (part D), respondents were requested to indicate their extent of agreement with the existence of a given list of key elements of readiness/conditions towards adopting any new innovation (lean construction for the purpose of this study) in their firms, as identified by Ruikar *et al*. (2006). Part A, B and C of the second section of the questionnaire were therefore used to identify the facilitators, benefits and barriers to adopting lean construction respectively in Nigeria, while the last part (part D) was used to establish/assess the level of readiness of Nigerian building consulting firms towards adopting lean construction.

3.3 Data Analysis

Descriptive statistics was used to gain an overview of the numeric data obtained from the self-administered questionnaire survey. Mean scores and relative rankings was used to analyse the first three sections of the second part of the questionnaire, i.e. to identify those factors which can be termed as facilitators, benefits and barriers to adopting lean construction in the Nigerian construction industry. A reliability analysis using the Cronbach's alpha, was then performed to

determine the internal consistency and thus, the reliability of the scale used in the survey questionnaire.

The last section of the second part of the questionnaire (readiness assessment), was analysed using the VERDICT readiness assessment criteria/report outlined by Ruikar *et al.* (2006). The VERDICT model was adopted for the readiness assessment in this study because just like Abubakar (2012) noted, it is applicable to assess the readiness level of construction companies, departments within a company, or even individual work groups within a department. Moreover, traffic light indicator used in this model highlights the organisation strengths and weaknesses, clearly indicating areas that need improvement. As outlined by Ruikar *et al*. (2006), the readiness assessment report includes data in textual and graphical formats and is divided into the following three sections:

- Table summarising average scores in each category;
- Radar diagram of overall scores; and
- Summary of all responses.

The table summarising average scores in each category, presents the responses in each category i.e. Management, People, Process, and Technology and records the average score in each category. As outlined by Ruikar *et al.* (2006) the scores are averaged, and depending on the average score, the respondents are presented with 'traffic light' indicators i.e. red, green and amber lights, to visually indicate their readiness in each category, where:

- An average score greater than or equal to zero and less than 2.5 is red. Red indicates that several aspects (within a category) need urgent attention to achieve readiness; and
- An average score greater than or equal to 2.5 and less than 3.5 is amber. Amber indicates that certain aspects (within a category) need attention to achieve readiness; and

- An average score greater than or equal to 3.5 is green. This indicates that the end-user organisation has adequate capability and maturity in these aspects and therefore is ready (in those respects).

The summary of all responses on the other hand, includes a list of all the statements included in each category and the corresponding score for each response, as well as highlights of specific points within each category that need attention to achieve readiness (Ruikar *et al.,* 2006).

For the purpose of this study however, only the textual formats of the readiness assessment report (table summarising average scores in each category and summary of all responses), was adopted. The graphical format of the report (radar diagram of overall scores) was not considered because as explained by Ruikar *et al*. (2006), the radar diagram gives the respondents a visual representation of their overall readiness in comparison to the best-of-breed in construction. Best-of-breed for the Nigerian construction industry in terms of lean construction is however not available.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Response Rate and Information relating to Respondents

Table 4.1: Percentage of Questionnaires Returned and Not Returned

Questionnaires	Number	Percentage
Distributed	360	100
Completed & returned	130	36
Not returned	230	64

Table 4.2: Information relating to Respondents

Services rendered	**Number**	**Percentage**
Project Management consultancy	17	13
Architectural consultancy	35	27
Quantity Surveying consultancy	37	29
Structural Engineering consultancy	27	21
Mechanical & Electrical consultancy	14	10
Rank/Position within firm		
Strategic/senior management	35	27
Middle management	78	60
Knowledge/Lower management	10	8
Operational level	7	5
Years of existence of firm		
Less than 5 year	17	5
6 to 10 years	19	15
11 to 15 years	31	24
16 to 20 years	45	34
More than 20 years	28	22

Table 4.1 shows the response rate of respondents in the study. As shown in this Table, out of a total of 360 questionnaires distributed, only 130 (36%) were completed and returned, while the remaining 230 (64%) were not returned. However, going by Moser and Kalton (1971)'s assertion that the result of a survey could be considered as biased and of little significance if the return rate was lower than 30-40%, the number of questionnaires completed and returned were therefore considered adequate for analysis.

Table 4.2 provides information relating to respondents for the study. As shown in the table, 27% of the respondents were engaged in Architectural consultancy, 29% were engaged in Quantity Surveying consultancy, while 21% and 13% were engaged in structural engineering consultancy and project management consultancy respectively. The remaining 10% of the respondents were engaged in Mechanical & Electrical consultancy. Also, as shown in the Table, 27% of the respondents belonged to the strategic/senior management level, 60% belonged to the middle management level, while only 8% and 5% belonged to the knowledge/lower management level and operational levels respectively. It can also be seen from Table 2, that 35% of the respondents had 16-20 years of experience, 24% had 11-15years of experience, 22% had more than 20 years of experience, while 15% and 5% had 6-10years of experience and less than 5 years of experience respectively. Based on the foregoing information about the respondents to the study, it is reasonable to conclude that reliable information was derived for the study since majority of the respondents did not only belonged to consultancies which are actively involved in the construction industry activities, but also belonged to top management in their respective firms, with a relatively high number of years of experience.

4.2 Facilitators and Potential Benefits for adopting LC

Table 4.3: Facilitators for adopting Lean Construction

Facilitators	Respondents' assessments					Mean	SD	Rank
	1	2	3	4	5			
Availability of trained professionals	0	0	5	59	66	4.47	0.57	1
Education and skills development	0	0	2	66	62	4.46	0.53	2
Commitment and cooperation of Professional bodies	0	0	7	71	52	4.35	0.58	3
Client interest in the use of LC in their project.	0	0	19	57	54	4.27	0.70	4
Attitudinal change	0	0	26	48	56	4.23	0.76	5
Top Management support and commitment	0	0	24	63	43	4.15	0.71	6
Government Policy via legislation	2	7	50	45	26	3.66	0.91	7

Table 4.4: Reliability Statistics

Cronbach's Alpha	No of Items
0.991	130

Table 4.5: Potential Benefits for adopting Lean Construction

Benefits	Respondents' assessments					Mean	SD	Rank
	1	2	3	4	5			
Reduced costs, less waste	0	0	3	54	73	4.54	0.54	1
Improved safety and health	0	2	5	69	54	4.35	0.63	2
Improved quality, fewer defects	0	0	7	73	50	4.33	0.58	3
Improved design	0	0	8	72	50	4.32	0.59	4
More satisfied clients	0	0	12	76	42	4.23	0.60	5
Productivity gains	0	0	22	80	28	4.05	0.62	6
Shorter construction periods	0	0	28	71	31	4.02	0.68	7
Greater predictability	0	8	50	57	15	3.61	0.77	8
Sub-contractors able to make better money	0	7	52	59	12	3.58	0.73	9
Operatives able to make better money	0	5	61	52	12	3.55	0.72	10

Table 4.6: Reliability Statistics

Cronbach's Alpha	No of Items
0.995	130

Table 4.3 shows the extent of agreement of Nigerian building consulting firms with factors which can be termed as facilitators for adopting lean construction in the Nigerian construction industry. Similarly, Table 4.5 shows the extent of agreement of respondents (Nigerian Building Consulting firms) with potential benefits of adopting lean construction in the Nigerian construction industry. As shown in these Tables, Nigerian building consulting firms ranked availability of trained professionals and Education and skills development as the two most important facilitators for adopting lean construction in the Nigeria construction industry, while reduced cost and less waste, as well as improved safety and health were ranked as the two most important benefits for adopting lean construction in the Nigeria construction industry. Tables 4.4 and Table 4.6 shows the Cronbach's alpha computed to measure the internal consistency among ratings of respondents and thus, the reliability of the scales used for determining factors which can be termed as the facilitator to adopting lean construction as well as the potential benefits of adopting lean construction in the Nigeria construction industry. As shown in these Tables, the Cronbachs alpha was very close to one, indicating the scales used were reliable and the respondents understood the questions being put forward to them in the questionnaire.

4.3 Barriers to adopting Lean Construction in the Nigerian Construction Industry

Table 4.7: Barriers to adopting lean construction

Barriers	**Respondents' assessments**					**Mean**	**SD**	**Rank**
	1	**2**	**3**	**4**	**5**			
Management related Barriers								
Inadequate preplanning	0	2	14	38	76	4.45	0.75	1
Poor planning	2	2	7	64	55	4.29	0.77	2

Lack of top management support and commitment	0	2	19	57	52	4.22	0.75	3
Poor project definition	0	5	17	52	56	4.22	0.82	4
Poor communication	2	5	7	64	52	4.22	0.84	4
Poor procurement selection strategies	5	0	23	59	43	4.04	0.93	6
Long implementation period	0	10	14	73	33	3.99	0.82	7
Delay in decision making	0	0	26	85	19	3.95	0.59	8
Inadequate resources	5	0	23	78	24	3.89	0.84	9
Unsuitable organisational structure	2	7	26	64	31	3.88	0.89	10
Use of substandard components	2	10	26	61	31	3.84	0.93	11
Absence of long term planning	0	7	38	54	31	3.84	0.85	11
Lack of equipment	2	9	26	71	22	3.78	0.86	13
Lack of client and supplier involvement	2	10	35	57	26	3.73	0.92	14
Lack of steady/work engagement	0	12	33	73	12	3.65	0.77	15
Delay in materials delivery	0	2	54	64	10	3.63	0.65	16
Lack of time for innovation	5	13	28	64	20	3.62	0.99	17
Lack of customer focus	2	9	50	52	17	3.56	0.86	18
Lack of supply chain integration	2	9	48	57	14	3.55	0.84	19
Materials scarcity	4	22	36	55	13	3.39	0.98	20
Financial related Barriers								
Corruption	3	2	19	54	52	4.15	0.89	1
Risk aversion	0	0	19	78	33	4.11	0.63	2
Inflation	2	2	12	88	26	4.03	0.70	3
Inadequate projects' funding	2	3	26	66	33	3.96	0.83	4
Lack of incentives and motivation	0	0	21	97	12	3.93	0.50	5
Implementation cost	0	0	45	69	16	3.78	0.65	6
Poor professional wages	0	5	57	61	7	3.54	0.66	7
Educational related Barriers								
Inadequate exposure to requirements for lean implementation	3	2	5	28	92	4.57	0.83	1
Lack of training	5	0	7	54	64	4.32	0.89	2
Lack of awareness programmes	2	2	7	76	43	4.2	0.74	3
Lack of understanding	5	2	10	61	52	4.18	0.93	4
Lack of information sharing	2	5	17	50	56	4.18	0.91	4
Lack of technical skills	7	0	7	66	50	4.17	0.95	6
Inadequate knowledge	5	0	10	80	35	4.08	0.83	7
Lack project team skills	5	5	10	68	42	4.05	0.95	8
Difficulty in understanding concept	5	7	21	57	40	3.92	1.02	9
High-level illiteracy	10	5	24	63	28	3.72	1.09	10
Lack of holistic implementation	5	0	42	71	12	3.65	0.80	11
Governmental related Barriers								
Corruption practices	2	0	17	64	47	4.18	0.78	1
Inconsistency in policies	2	0	17	71	40	4.13	0.75	2
Government bureaucracy	0	2	21	76	31	4.05	0.68	3
Inflation	5	0	35	57	33	3.87	0.93	4
Unsteady price commodities	0	0	33	87	10	3.82	0.55	5

Professional wages	0	5	50	64	11	3.62	0.70	6
Lack of social amenities and infrastructure	7	2	50	57	14	3.53	0.91	7
Materials unavailability	3	14	54	52	7	3.35	0.83	8
Technical related Barriers								
Inaccurate and incomplete designs	3	5	14	71	37	4.03	0.87	1
Lack of agreed implementation methodology	0	5	40	73	12	3.71	0.69	2
Poor performance measurement strategies	0	7	40	69	14	3.69	0.74	3
Incomplete designs	2	17	33	64	14	3.55	0.91	4
Lack of prefabrication, uncertainty in supply chain	5	7	50	64	4	3.42	0.81	5
Lack of design constructability	7	31	14	66	12	3.35	1.10	6
Lack of buildable designs	7	31	35	52	5	3.13	1.00	7
Human attitudinal related Barriers								
Misconceptions about lean practice	2	0	10	50	68	4.4	0.76	1
Fear of unfamiliar practices	0	0	12	68	50	4.29	0.63	2
Seen as too complex and alien	0	3	7	73	47	4.26	0.67	3
Lack of cooperation	5	0	12	71	42	4.12	0.87	4
Lack of teamwork	5	0	12	78	35	4.06	0.84	5
Poor leadership	0	3	33	54	40	4.01	0.81	6
Lack of team spirit	2	0	33	69	26	3.9	0.77	7
Leadership conflict	0	5	35	59	31	3.89	0.81	8
Cultural change	2	7	40	50	31	3.78	0.93	9
Poor understanding of client's brief	2	10	40	45	33	3.75	0.97	10
Lack of self-criticism	3	5	47	61	14	3.6	0.82	11
Over enthusiasms	0	5	59	52	14	3.58	0.74	12
Lack of transparency	0	7	54	57	12	3.57	0.74	13
Poor house keeping	5	23	43	45	14	3.31	1.01	14

Table 4.8: Reliability Statistics

Cronbach's Alpha	No of Items
0.989	130

Table 4.7 presents the extent of agreement of Nigerian building consulting firms with barriers which could militate against the adoption lean construction in Nigeria. As shown in this Table, the barriers to adopting lean construction in the Nigerian construction industry were considered under five headings as identified by Abubakar *et al.* (2010)'s work. The barriers were ranked

using their respective mean score under each heading. It can be concluded that Nigerian building consulting firms consider all barriers as factors which militate against the adoption of lean construction in the Nigerian construction industry. As shown in Table 4.7, inadequate preplanning, poor planning and lack of top management and support were ranked as the most important management related barriers to the adoption of lean construction in the Nigerian construction industry; corruption, risk aversion and inflation were ranked as the most important financial related barrier to the adoption of lean construction; Inadequate exposure to requirements for lean implementation, lack of training and lack of awareness programme were ranked as the most important educational related barrier to the adoption of lean construction; corruption practices, inconsistency in policies and government bureaucracy were ranked as the most important governmental related barrier to the adoption of lean construction; inaccurate and incomplete designs, lack of agreed implementation methodology and poor performance measurement strategies were ranked as the most important technical related barrier to the adoption of lean construction; misconceptions about lean practice, fear of unfamiliar practices and seen as too complex and alien were ranked as the most important Human attitudinal related barrier to the adoption of lean construction.

Similarly, Table 4.8 shows the Cronbach's alpha computed to measure the internal consistency among ratings of respondents and thus, the reliability of the scales used for determining factors which can be termed as the barriers to adopting lean construction in the Nigeria construction industry. As shown in these Tables, the Cronbachs alpha was very close to one (0.989), indicating the scales used were reliable and the respondents understood the questions being put forward to them in the questionnaire.

4.4 Readiness Assessment of Nigerian consulting firms

Table 4.9: Summary of responses from Nigerian Building Consulting firms

Readiness Condition	Project Managers						Architects						Quantity Surveyors						Structural Engineers						M&E Engineers					
	Respondent's assessments					**N**	**Respondent's assessments**					**N**	**Respondent's assessments**					**N**	**Respondent's assessments**					**N**	**Respondent's assessments**					**N**
	1	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**	
Management readiness																														
Our management is aware of LC and recognized the benefits of LC	0	4	6	5	4	19	0	8	14	9	8	39	0	9	15	10	8	42	0	7	11	7	6	31	0	3	6	4	3	16
All levels of management in our organization have a LC mind approach	2	7	5	4	1	19	4	15	11	7	2	39	4	16	12	8	2	42	3	12	9	6	1	31	1	6	5	3	1	16
We have a policy for training and capacity building to keep our staff up to date with LC tools	2	7	5	5	0	19	4	14	10	11	0	39	4	15	11	12	0	42	3	11	8	9	0	31	2	6	4	4	0	16
LC strategy is well communicated to all levels within the organisation	2	10	3	4	0	19	4	21	6	7	1	39	4	22	7	8	1	42	3	16	5	6	1	31	2	8	3	3	0	16
We have provided adequate financial resources to facilitate LC in our practices	3	8	4	4	0	19	6	17	8	8	0	39	6	18	9	9	0	42	4	14	7	6	0	31	2	7	4	3	0	16
Process/Project readiness																														
We display high level of quality assurance	0	2	1	8	8	19	0	4	3	16	16	39	0	3	3	18	18	42	0	3	2	13	13	31	0	1	1	7	7	16
Our use of LC will reduce risks on overall project management	0	2	3	7	7	19	0	3	7	14	15	39	1	4	6	15	16	42	0	3	5	11	12	31	0	2	2	6	6	16
Our organisation focus on client expectations	0	2	2	9	6	19	0	4	4	19	12	39	1	4	4	21	12	42	1	2	6	13	9	31	0	1	2	8	5	16
We have adequate competent design team and construction process	1	1	3	8	6	19	2	3	7	16	11	39	2	3	8	17	12	42	0	3	3	15	10	31	1	1	3	7	4	16
Our organisaton is flexible enough to accommodate LC	0	1	4	10	4	19	1	2	9	18	9	39	1	2	9	21	9	42	0	2	7	15	7	31	0	1	3	8	4	16
Our business process support and encourage interdisciplinary/interorganisational collaboration	0	1	6	8	4	19	0	2	13	17	7	39	0	2	14	18	8	42	0	1	10	14	6	31	0	1	5	7	3	16
Our use of LC will improve Health and safety during project delivery	1	2	5	9	2	19	1	4	9	19	6	39	1	5	10	20	6	42	1	3	7	15	5	31	0	2	4	8	2	16
Our current ICT infrastructure is adequate for supporting LC	0	5	7	5	2	19	1	9	14	11	4	39	0	10	15	12	5	42	0	7	11	9	4	31	0	4	6	4	2	16

People readiness																																
We have people with ability to implement change and move quickly to adopt the use of LC	0	2	5	8	4	19	0	5	11	16	7	39	0	5	12	17	8	42	0	4	9	12	6	31	0	2	4	7	3	16
Our staff have the necessary levels of IT literacy, functional expertise and skills to use LC	1	2	7	7	2	19	1	4	14	15	5	39	1	5	15	16	5	42	1	3	11	12	4	31	0	2	6	6	2	16
We are committed to address any issues/inhibitions that any staff may have about using LC principles	0	4	6	6	3	19	0	8	13	13	5	39	0	9	14	14	5	42	0	7	10	10	4	31	0	4	5	5	2	16
Our current organsational structure provides an environment that is well suited to use LC principles	1	4	6	6	2	19	2	9	11	13	4	39	2	9	12	14	5	42	2	7	9	10	3	31	1	3	5	5	2	16
Our staff fully understand the importance of training required for using LC tools	1	4	7	5	2	19	3	8	14	10	4	39	3	8	15	11	5	42	2	6	11	8	4	31	1	3	6	4	2	16
We have devised training procedures that will enable our staff to effectively use LC tools	2	6	6	4	1	19	4	11	13	9	2	39	4	12	14	9	3	42	3	9	10	7	2	31	1	5	5	4	1	16
Technology readiness																																
We are familiar with the use specialist software applications related to our expertise.	0	2	5	8	4	19	0	4	10	16	9	39	0	4	11	18	9	42	0	3	8	13	7	31	0	2	4	7	3	16
Our current ICT systems are flexible to accommodate rapid change and scalability	0	3	8	6	2	19	0	6	16	12	5	39	0	6	18	13	5	42	0	4	13	10	4	31	0	2	7	5	2	16
Our organization have well defined IT policy	1	4	8	6	0	19	2	9	16	11	1	39	2	9	17	12	2	42	2	7	12	9	1	31	1	3	6	5	1	16
We have effective intranet and extranet facilities to facilitate information sharing and interoperability.	3	5	7	4	0	19	5	11	13	9	1	39	5	11	15	9	2	42	4	8	11	7	1	31	2	4	6	3	1	16

Table 4.10: Readiness of Nigerian Consulting firms to adopt Lean Construction

Readiness Condition	Project Management				Architects				Quantity Surveyors				Structural Engineers				M&E Engineers			
	Mean	SD	Rank	AMS	Mean	SD	Rank	AMS	Mean	SD	Rank	AMS	Mean	SD	Rank	AMS	Mean	SD	Rank	AMS
Management readiness																				
Our management is aware of LC and recognized the benefits of LC	3.47	1.07	1		3.44	1.05	1		3.40	1.04	1		3.39	1.05	1		3.44	1.03	1	
All levels of management in our organization have a LC mind approach	2.74	1.10	2		2.69	1.06	3		2.71	1.04	3		2.68	1.01	3		2.81	1.05	2	
We have a policy for training and capacity building to keep our staff up to date with LC tools	2.68	1.00	3	2.77	2.72	1.00	2	2.76	2.74	0.99	2	2.78	2.74	1.00	2	2.77	2.63	1.02	3	2.76
LC strategy is well communicated to all levels within the organisation	2.47	0.96	4		2.49	1.00	4		2.52	0.99	4		2.55	1.03	4		2.44	0.96	5	
We have provided adequate financial resources to facilitate LC in our practices	2.47	1.02	4		2.46	1.00	5		2.50	0.99	5		2.48	0.96	5		2.50	0.97	4	
Process/Project readiness																				
We display high level of quality assurance	4.16	0.96	1		4.13	0.95	1		4.21	0.87	1		4.16	0.93	1		4.25	0.86	1	
Our use of LC will reduce risks on overall project management	4.00	1.00	2	3.8	4.05	0.94	2	3.8	3.98	1.07	2	3.8	4.03	0.98	2	3.84	4.00	1.03	3	3.83

Our organisation focus on client expectations	4.00	0.94	2		4.00	0.92	3		3.93	1.00	3		3.87	1.02	4		4.06	0.85	2	
We have adequate competent design team and construction process	3.89	1.10	4		3.79	1.10	5		3.81	1.09	5		4.03	0.91	2		3.75	1.13	5	
Our organisaton is flexible enough to accommodate LC	3.89	0.81	5		3.82	0.94	4		3.83	0.91	4		3.87	0.85	4		3.94	0.85	4	
Our business process support and encourage interdisciplinary/interorganisational collaboration	3.79	0.85	6		3.74	0.82	6		3.76	0.82	6		3.81	0.79	6		3.75	0.86	5	
Our use of LC will improve Health and safety during project delivery	3.47	1.02	7		3.64	0.96	7		3.60	0.96	7		3.65	0.98	7		3.63	0.89	7	
Our current ICT infrastructure is adequate for supporting LC	3.21	0.98	8		3.21	1.00	8		3.29	0.97	8		3.32	0.98	8		3.25	1.00	8	
People readiness																				
We have people with ability to implement change and move quickly to adopt the use of LC	3.74	0.93	1		3.64	0.93	1		3.67	0.93	1		3.65	0.95	1		3.69	0.95	1	
				3.28				3.28				3.3				3.28				3.31
Our staff have the necessary levels of IT literacy, functional expertise and skills to use LC	3.37	1.01	3		3.49	0.94	2		3.45	0.94	2		3.48	0.96	2		3.50	0.89	2	

We are committed to address any issues/inhibitions that any staff may have about using LC principles	3.42	1.02	2		3.38	0.96	3		3.36	0.96	3		3.35	0.98	3		3.31	1.01	3	
Our current organsational structure provides an environment that is well suited to use LC principles	3.21	1.08	4		3.21	1.08	4		3.26	1.08	4		3.16	1.10	5		3.25	1.13	4	
Our staff fully understand the importance of training required for using LC tools	3.16	1.07	5		3.10	1.10	5		3.17	1.10	5		3.19	1.11	4		3.19	1.11	5	
We have devised training procedures that will enable our staff to effectively use LC tools	2.79	1.08	6		2.85	1.06	6		2.88	1.09	6		2.87	1.09	6		2.94	1.06	6	
Technology readiness																				
We are familiar with the use specialist software applications related to our expertise.	3.74	0.93	1		3.77	0.93	2		3.76	0.91	1		3.77	0.92	1		3.69	0.95	1	
Our current ICT systems are flexible to accommodate rapid change and scalability	3.37	0.90	2		3.41	0.91	1		3.40	0.89	2		3.45	0.89	2		3.44	0.89	2	
				3.18				3.23				3.26				3.25				3.27
Our organization have well defined IT policy	3.00	0.88	3		3.00	0.92	3		3.07	0.95	3		3.00	0.97	3		3.13	1.02	3	
We have effective intranet and extranet facilities to facilitate information sharing and interoperability.	2.63	1.01	4		2.74	1.04	4		2.81	1.06	4		2.77	1.06	4		2.81	1.11	4	

Table 4.11: Reliability Statistics

Cronbach's Alpha	No of Items
0.990	130

Table 4.10 presents the readiness of Nigerian building consulting firms to adopt lean construction, with respect to the four categories considered important for an organisation's readiness to adopt a new innovation, as outlined by Ruikar *et al.* (2006)'s VERDICT model. The Table shows the response rate of respondents (Nigerian building consulting firms) with respect to the various questions put forward in each category. It also shows how the average mean scores presented in the table summarising average score in each category were arrived at. Table 4.11 on the other hand, shows the Cronbach's alpha computed to measure the internal consistency among ratings of respondents and thus, the reliability of the scales used for determining the readiness of Nigerian building consulting firms to adopting lean construction in the Nigerian construction industry. As shown in this Table, the Cronbachs alpha was very close to one (0.990), indicating that the scales used were reliable and the respondents understood the questions being put forward to them in the questionnaire.

Table 4.12: Table summarising average scores in each category for Nigeria building consulting firms, based on Ruikar *et al*. (2006) defined boundaries.

Consulting firm	Category Name	Average Score	Situation Based on Ruikar's boundaries
Project Management	Management	2.77	Amber
	Process/Project	3.80	Green
	People	3.28	Amber
	Technology	3.18	Amber

Architectural	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	3.3	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

Table 4.12 presents average scores indicating the level of readiness of each professional practice firm in each category i.e. management, process/project, people and technology. As outlined by Ruikar *et al.* (2006) an average score greater than or equal to zero and less than 2.5 is red, and indicates that several aspects (within a category) need urgent attention to achieve readiness; an average score greater than or equal to 2.5 and less than 3.5 is amber, and indicates that certain aspects (within a category) need attention to achieve readiness; and an average score greater than

or equal to 3.5 is green, and indicates that the end-user organisation has adequate capability and maturity in these aspects and therefore is ready (in those respects).

For this study however, it is evident from Table 4.12, that; the average scores for the categories; management, people as well as technology, were all greater than 2.5, but less than 3.5 (amber), for all the consulting firms considered in the study (Project management, Architectural, Quantity Surveying, Structural Engineering and M&E engineering firms in Nigeria). This clearly shows that Project management firms, Architectural firms, Quantity Surveying firms, Structural Engineering firms and M&E engineering firms in Nigeria all require attention on certain aspects to achieve management, people as well as technology readiness for adopting Lean Construction.

Also, as shown in Table 4.12, for all the building consulting firms considered, process/project was the only category in which an average score greater than 3.5 (green) was obtained. This also clearly indicates that Project management firms, Architectural firms, Quantity Surveying firms, Structural Engineering firms and M&E engineering consulting firms in Nigeria have adequate capability and maturity to in this aspects and it's therefore ready to adopt new innovations (Lean Construction).

Table 4.13: Final Lean Construction Readiness Report for Nigerian Building Consulting Firms

Readiness Condition	**Score**				
	PM firms	Arc. Firms	QS firms	Str. Eng firms	M&E firms
Management readiness					
Our management is aware of LC and recognized the benefits of LC	3.47	3.44	3.40	3.39	3.44
All levels of management in our organization have a LC mind approach	2.74	2.69	2.71	2.68	2.81
We have a policy for training and capacity building to keep our staff up to date with LC tools	2.68	2.72	2.74	2.74	2.63

LC strategy is well communicated to all levels within the organisation	2.47	2.49	2.52	2.55	2.44
We have provided adequate financial resources to facilitate LC in our practices	2.47	2.46	2.50	2.48	2.50
Process/Project readiness					
We display high level of quality assurance	4.16	4.13	4.21	4.16	4.25
Our use of LC will reduce risks on overall project management	4.00	4.05	3.98	4.03	4.00
Our organisation focus on client expectations	4.00	4.00	3.93	3.87	4.06
We have adequate competent design team and construction process	3.89	3.79	3.81	4.03	3.75
Our organisaton is flexible enough to accommodate LC	3.89	3.82	3.83	3.87	3.94
Our business process support and encourage interdisciplinary/interorganisational collaboration	3.79	3.74	3.76	3.81	3.75
Our use of LC will improve Health and safety during project delivery	3.47	3.64	3.60	3.65	3.63
Our current ICT infrastructure is adequate for supporting LC	3.21	3.21	3.29	3.32	3.25
People readiness					
We have people with ability to implement change and move quickly to adopt the use of LC	3.74	3.64	3.67	3.65	3.69
Our staff have the necessary levels of IT literacy, functional expertise and skills to use LC	3.37	3.49	3.45	3.48	3.50
We are committed to address any issues/inhibitions that any staff may have about using LC principles	3.42	3.38	3.36	3.35	3.31
Our current organsational structure provides an environment that is well suited to use LC principles	3.21	3.21	3.26	3.16	3.25
Our staff fully understand the importance of training required for using LC tools	3.16	3.10	3.17	3.19	3.19
We have devised training procedures that will enable our staff to effectively use LC tools	2.79	2.85	2.88	2.87	2.94
Technology readiness					
We are familiar with the use specialist software applications related to our expertise.	3.74	3.77	3.76	3.77	3.69
Our current ICT systems are flexible to accommodate rapid change and scalability	3.37	3.41	3.40	3.45	3.44
Our organization have well defined IT policy	3.00	3.00	3.07	3.00	3.13
We have effective intranet and extranet facilities to facilitate information sharing and interoperability.	2.63	2.74	2.81	2.77	2.81

Table 4.13 shows the final readiness report of the readiness assessment carried out in the study, and provides a summary of responses to all statements put forward in each category. The essence of this report, as noted by Ruikar *et al*. (2006) is to highlight specific points within each category that need attention to achieve readiness, thereby allowing companies to focus on, and improve on, those specific aspects within each category, even if they may have achieved readiness in that category.

As shown in Table 4.13, Project Management firms, Architectural firms, Quantity Surveying firms, Structural Engineering firms as well as M&E consulting firms in the Nigeria construction industry, each scored less than 3.5 in all aspects of management readiness. This thus clearly indicates that they all require attention on all aspects of management to achieve management readiness to adopt lean construction. Similarly, as shown in the Table, Architectural firms, Quantity Surveying firms, Structural Engineering firms and M&E consulting firms, scored less than 3.5 in just one aspect of project/process readiness i.e.; 'our current ICT and infrastructure is adequate for supporting lean construction", while Project Management firms scored less than 3.5 in two aspects i.e.; 'our current ICT and infrastructure is adequate for supporting lean construction" and 'our use of lean construction will improve health and safety during project delivery'. This clearly justifies the "GREEN" boundary which they all belonged to, and indicates that the building consulting firms are close to attaining people readiness as they require attention on at most, two aspects of people readiness.

Furthermore, Table 4.13 shows that Project Management firms, Architectural firms, Quantity Surveying firms, Structural Engineering firms as well as M&E consulting firms in the Nigeria construction industry all scored less than 3.5 in almost all aspects of people readiness and technology readiness respectively. This also clearly justifies why all the consulting firms all lie

in the amber boundary for these categories and indicates that a lot of attention is required to achieve readiness in both categories.

4.5 Comparing Readiness of Nigerian Building Consulting Firms to adopt LC

Table 4.14: Comparing Readiness of Nigerian Building Consulting Firms to adopt LC

Descriptives								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Project Management	4	3.258	0.424	0.212	2.583	3.932	2.77	3.8
Architectural	4	3.268	0.425	0.213	2.591	3.944	2.76	3.8
Quantity Surveying	4	3.285	0.417	0.208	2.622	3.948	2.78	3.8
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			

Table 4.14 shows the result of a one-way ANOVA conducted to compare and thus, determine if there is a difference between the levels of readiness of the various Nigerian building consulting firms to adopt lean construction. As shown in this Table, the significance value is above 0.05 (1.00), indicating clearly that there is no significant difference between the levels of readiness of the various Nigerian building consulting firms to adopt lean construction.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings

The following are the findings from the analysis carried out in the study:

i. Reduced cost and less waste, as well as improved safety and health are the two most important benefits of adopting lean construction principles in the Nigerian construction industry.

ii. Availability of trained professionals and Education and skills development are the two most important facilitators for adopting lean construction principles in the Nigerian construction industry.

iii. Inadequate preplanning, poor planning and lack of top management and support are the most important management related barriers to the adoption of lean construction in the Nigerian construction industry; corruption, risk aversion and inflation are the most important financial related barrier to the adoption of lean construction in the Nigerian construction industry; inadequate exposure to requirements for lean implementation, lack of training and lack of awareness programme are the most important educational related barrier to the adoption of lean construction in the Nigerian construction industry; corruption practices, inconsistency in policies and government bureaucracy are the most important governmental related barriers to the adoption of lean construction in the Nigeria construction Industry; inaccurate and incomplete designs, lack of agreed implementation methodology and poor performance measurement strategies are the most important technical related barrier to the adoption of lean construction in the Nigerian

construction industry, while; misconceptions about lean practice, fear of unfamiliar practices and seen as too complex and alien are the most important human attitudinal related barrier to the adoption of lean construction in the Nigerian construction industry.

iv. Nigerian building consulting firms have process/project readiness to adopt lean construction, but do not have management, people and technology readiness to adopt lean construction principles.

5.2 Conclusion

To the building consulting firms in Nigeria, the study reveals that the level of awareness of lean construction principles is increasing. This study can be useful to the Nigerian construction industry professionals by identifying and evaluating the effects of lean construction barriers and facilitators where the building consulting firms can focus their attention and resources on the real issues and by assessing the difficulty associated with overcoming the various barriers and facilitators where firms can tackle the easiest first. Additionally, they can use the priority list as ranked to enhance their chances of adopting lean construction principles.

The readiness assessments result shows that Nigerian building consulting firms have process/project readiness to adopt lean construction principles, but needs to give attention to management, people and technology to achieve readiness to adopting lean construction principles. The Nigeria building consulting firms is not yet ready to adopt lean construction principles which indicates that certain aspects (within a category) need attention to achieve readiness.

5.3 Recommendation

The study's recommendations were made based on the findings, with a view to adopting lean construction principles in the Nigerian construction industry.

(a) More awareness of lean construction principles and its potential benefits via education and training to professional bodies, tertiary institutions offering any building construction related programmes and stakeholder in the construction Industry.

(b) In facilitating the adoption of lean Construction Principles, attention should be focused on government policy via legislation, attitudinal change, top management support and commitment, client interest in the use of lean construction principle in their project and commitment and cooperation of professional bodies.

(c) Further research should be conducted to establish the readiness levels of all other sectors of the Nigerian construction industry for the adoption of lean construction principles. This is because the adoption cannot just be achieved by one segment of the industry. It is a collaboration issue which needs all the segments of the industry such as contractors, clients, suppliers, manufacturers and government to have a fair level of readiness if the industry is to benefit from the adoption of lean construction principles.

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APPENDIX A

DEPARTMENT OF QUANITY SURVEYING
FACULTY OF ENVIRONMENTAL DESIGN,
AHMADU BELLO UNIVERSITY-ZARIA

An Appraisal of the Readiness of Nigerian Building Consulting Firms to Adopt Lean Construction Principles

Dear Respondent,

I am undertaking a research as part of my M. Sc. Programme at the Department of Quantity Surveying, Ahmadu Bello University-Zaria entitled "***An Appraisal of the Readiness of Nigerian Building Consulting Firms to Adopt Lean Construction (LC) Principles"***. The outcome of the study is expected to provide clear insight on the current state of readiness of building consulting firms towards adopting LC principles.

I would be grateful if you spare some time to complete the questionnaire, which should only take few minutes.

The information provided will be treated with utmost confidentially and will be used for data analysis only.

I would be glad to share the summary of my findings with you, if you provide your contact details at the end of the questionnaire.

Thank you very much for your time.

Yours faithfully,

Olajide Olamilokun.
jidous4ril@yahoo.com

INTRODUCTION

- **Indicate your answer/response with a tick in the box that corresponds to your choice or where required, give a short written reply in the space provided.**
- **Response provided in section B should be with reference to your Organisational Readiness.**

SECTION A: ***Demographic background of respondents***

1. Which of the following best describes the services delivered by your firm?
   a. Project Management Consultancy 〔 〕 b. Architectural Consultancy〔 〕
   c. Quntity Surveying Consultancy〔 〕 d. Structural Engineering Consultancy〔 〕
   e. Mechanical & Electrical Consultancy〔 〕 f. Other (Please Specify)……

2. Which of the following best describes your rank/position within your firm?
   a. Strategic/senior management level 〔 〕 b. middle management level 〔 〕
   c. Knowledge/lower management level 〔 〕 d. operational level 〔 〕

3 Years of experience of the company in construction industry
   a. Less than 5 years 〔 〕 b. 6-10 yrs 〔 〕 c. 11-15yr 〔 〕 d. 16-20yrs 〔 〕
   b. 21-25yrs 〔 〕 e. More than 25yrs 〔 〕

SECTION B: ***Issues Related to Lean Construction***

Part A: **Indicate the extent of your agreement with the following as facilitators for adopting LC principles in the Nigerian Construction Industry using a scale of 1 and 5 where 1= Strongly disagree, 2=Disagree, 3=Somewhat agree, 4=Agree and 5= Strongly agree.**

Facilitators	**1**	**2**	**3**	**4**	**5**
Government Policy via legislation					
Availability of trained professionals					
Attitudinal change					
Commitment and cooperation of Professional bodies					
Top Management support and commitment					
Education and skills development					
Client interest in the use of LC in their project.					
Others (Please state)					

Part B: **Indicate the extent of your agreement with the following potential benefits for adopting LC principles in the Nigerian Construction Industry using a scale of 1 and 5 where 1= Strongly disagree, 2=Disagree, 3=Somewhat agree, 4=Agree and 5= Strongly agree.**					
Potential Benefits of LC	**1**	**2**	**3**	**4**	**5**
More satisfied clients					
Productivity gains					
Greater predictability					
Shorter construction periods					
Operatives able to make better money					
Sub-contractors able to make better money					
Improved design					
Reduced costs, less waste					
Improved safety and health					
Improved quality, fewer defects					
Others, (Please state)					
Part C: **Indicate the extent of your agreement with the following as barriers for adopting LC principles in the Nigerian Construction Industry using a scale of 1 and 5 where 1= Strongly disagree, 2=Disagree, 3=Somewhat agree, 4=Agree and 5= Strongly agree.**					
Barriers	**1**	**2**	**3**	**4**	**5**
Management issues					
Delay in decision making					
Lack of top management support and commitment					

Poor project definition					
Delay in materials delivery					
Lack of equipment					
Materials scarcity					
Lack of time for innovation					
Unsuitable organisational structure					
Lack of supply chain integration					
Poor communication					
Use of substandard components					
Lack of steady/work engagement					
Long implementation period					
Inadequate preplanning					
Poor procurement selection strategies					
Poor planning					
Inadequate resources					
Lack of client and supplier involvement					
Lack of customer focus					
Absence of long term planning					
Financial issues					
Corruption					
Inadequate projects' funding					
Inflation					
Implementation cost					

Poor professional wages					
Lack of incentives and motivation					
Risk aversion					
Educational issues					
Lack of understanding					
Lack of technical skills					
High-level illiteracy					
Lack of training					
Lack of holistic implementation					
Inadequate knowledge					
Lack project team skills					
Inadequate exposure to requirements for lean implementation					
Lack of awareness programmes					
Difficulty in understanding concept					
Lack of information sharing					
Governmental issues					
Government bureaucracy					
Inconsistency in policies					
Lack of social amenities and infrastructure					
Materials unavailability					
Unsteady price commodities					
Inflation					

Professional wages					
Corruption practices					
Technical issues					
Lack of buildable designs					
Incomplete designs					
Poor performance measurement strategies					
Lack of agreed implementation methodology					
Lack of prefabrication, uncertainty in supply chain					
Lack of design constructability					
Inaccurate and incomplete designs					
Human attitudinal issues					
Lack of transparency					
Cultural change					
Lack of team spirit					
Lack of self-criticism					
Lack of teamwork					
Lack of cooperation					
Poor house keeping					
Poor leadership					
Leadership conflict					
Poor understanding of client's brief					
Misconceptions about lean practice					

Over enthusiasms					
Seen as too complex and alien					
Fear of unfamiliar practices					
Part D: **Indicate the extent of your agreement with the existence of the following conditions in your organisation towards the adoption of LC principles using a scale of 1 and 5 where 1= Strongly disagree, 2=Disagree, 3=Somewhat agree, 4=Agree and 5= Strongly agree.**					
Organisational Readiness Assessment	**1**	**2**	**3**	**4**	**5**
Management Readiness					
Our management is aware of LC and recognized the benefits of LC					
All levels of management in our organization have a LC mind approach					
LC strategy is well communicated to all levels within the organisation					
We have provided adequate financial resources to facilitate LC in our practices					
We have a policy for training and capacity building to keep our staff up to date with LC tools					
Process/Project Readiness					
Our organisaton is flexible enough to accommodate LC					
Our business process support and encourage interdisciplinary/interorganisational collaboration					
We have adequate competent design team and construction process					
Our current ICT infrastructure is adequate for supporting LC					
Our use of LC will improve Health and safety during project delivery					
Our organisation focus on client expectations					
We display high level of quality assurance					
Our use of LC will reduce risks on overall project management					

People Readiness					
We have people with ability to implement change and move quickly to adopt the use of LC					
Our staff have the necessary levels of IT literacy, functional expertise and skills to use LC					
Our current organsational structure provides an environment that is well suited to use LC principles					
Our staff fully understand the importance of training required for using LC tools					
We have devised training procedures that will enable our staff to effectively use LC tools					
We are committed to address any issues/inhibitions that any staff may have about using LC principles					
Technology Readiness					
Our current ICT systems are flexible to accommodate rapid change and scalability					
We have effective intranet and extranet facilities to facilitate information sharing and interoperability.					
Our organization have well defined IT policy					
We are familiar with the use specialist software applications related to our expertise.					
Others, (Please state)					

SECTION C: ***CONTACT INFORMATION***

If you wish to receive a summary of the findings of this research work, please provide your organization's Name and email address/ below.