

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI, GHANA**

KNUST

**Enablers of Lean Construction Concept to Affordable Housing Schemes in
Ghana**

by

Peter Kofi Kyere (BSc. Building Technology)

**A Thesis Submitted To the Department of Building Technology,
College of Art and Built Environment**

in partial fulfilment of the requirements for the degree of

MASTERS OF SCIENCE

NOVEMBER 2016

DECLARATION

I hereby declare that this submission is my own work towards the MSc Construction Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

PETER K. KYERE (PG3551615)

.....
.....

Supervisor's Name

.....

Signature PROF. JOSHUA AYARKWA

.....

Supervisor's Name

.....

Signature

.....

Date

PROF. JOSHUA AYARKWA

.....

Supervisor's Name

.....

Signature

.....

Date

.....

Date

Student Name & ID

.....

Signature

.....
Date

Certified by:

Certified by:

DR. THEOPHILUS ADJEI -KUMI

.....

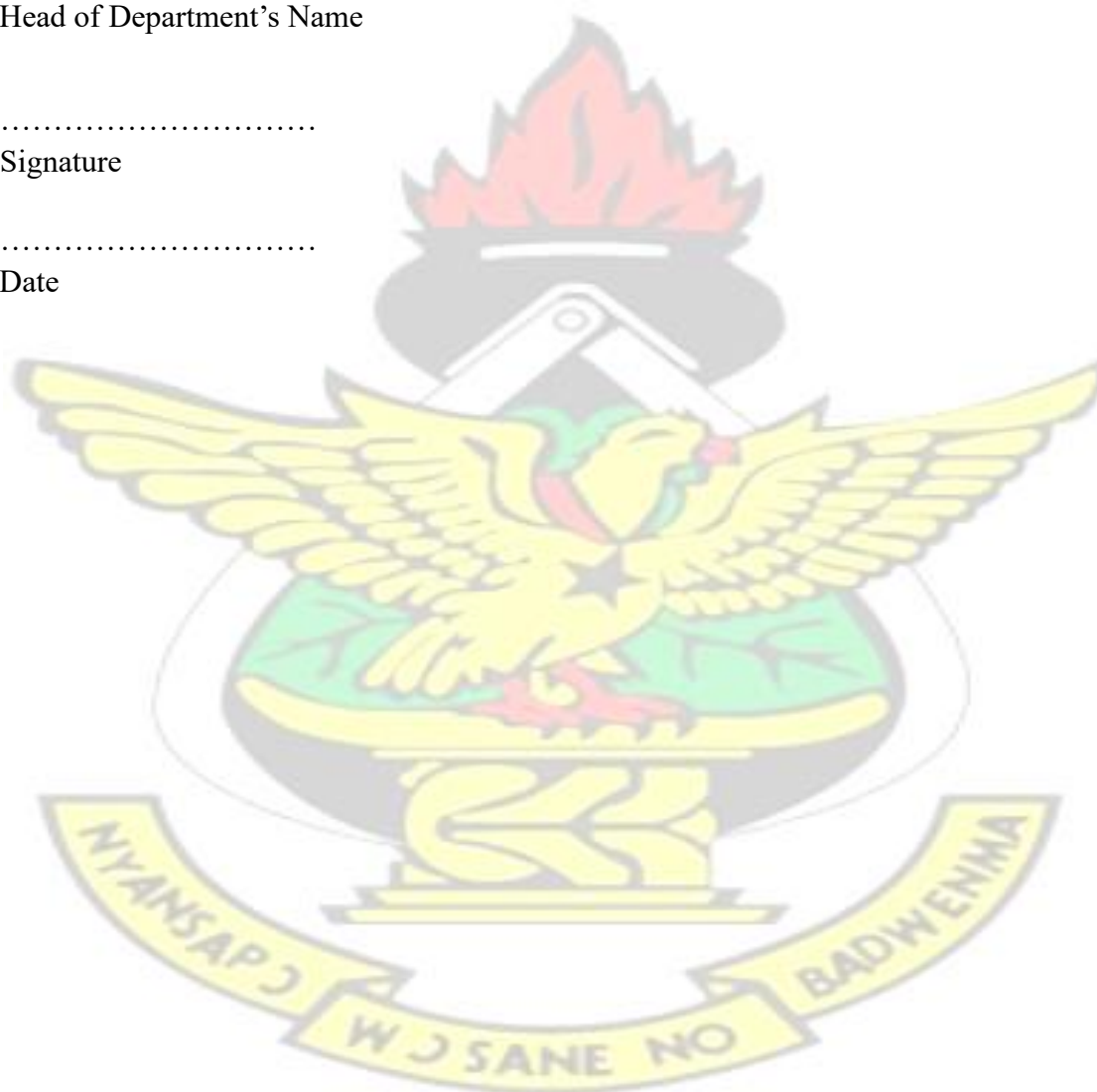
Head of Department's Name

.....

Signature

.....

Date



ABSTRACT

The effort to provide affordable housing, reduce construction waste and increase productivity has led to the adaptation of the concept of 'Lean Construction'. Assessing and implementing the techniques of the lean philosophy has become key for organizations in the industry of construction in the quest for incessant improvements.

The challenges faced in the implementation of the government of Ghana's affordable housing scheme coupled with the challenges in embracing and implementing the Lean Construction Concept is the main problem for this study. Consequently, the study identifies and assesses the enablers of lean construction with respect to the execution of Affordable Housing Schemes in the Ghanaian setting. The research objectives are to assess the perception of stakeholders on the concept of Affordable Housing, identify the potential barriers to the application of the Lean Construction Concept in Ghana and to identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana. A quantitative approach of data analysis involving an exploratory method of investigation was utilized in this study. A comprehensive review of literature together with questionnaire survey was undertaken among professionals in the construction industry of Ghana. The data collected were analyzed using the Statistical Package for Social Sciences Software (SPSS v20.0) using factor analysis;

Kaiser Meyer Olkin test, Bartlette's test of Sphericity to test the reliability and adequacy of the sample of factors studied. The potential barriers to the application of lean construction were identified and were laid open to factor analysis, which yielded three (3) categories of critical barriers considered as management related, construction related as well as design related barriers. The enablers for implementing lean construction in Affordable Housing were classified into four (4) main headings, namely; Organizational Culture factors; Relational factors; Leadership and Management factors; as well as Resource, Skills and Expertise factors. In addition, the benefits of implementation of lean construction identified in literature were grouped into environmental, social and

economic benefits. The research further revealed that the most significant barrier is ‘Lack of Awareness and training’, and the most significant enablers are ‘Business Plan and Vision, Management Commitment and Support’. Furthermore, the analysis derived from the questionnaire survey concluded that there are still greater number of construction stakeholders who are not aware of the Lean Construction philosophy. In addition, professionals in the built environment per the survey generally agree that Lean Construction would be beneficial to the Affordable Housing Scheme in Ghana. This research contributes to the body of knowledge by identifying success factors for lean construction concept implementation in the Affordable Housing Scheme in Ghana.

Keywords – Lean Construction, Affordable Housing, Barriers, Enablers, Drivers



TABLE OF CONTENTS

DECLARATION	ii
ABSTRACT	iv
LIST OF TABLES	viii
LIST OF FIGURES.....	ix
DEDICATION	x
ACKNOWLEDGEMENT	xi
CHAPTER ONE: _GENERAL INTRODUCTION.....	1
1.1 BACKGROUND OF THE STUDY	1
1.2 PROBLEM STATEMENT	3
1.3 RESEARCH QUESTIONS	5
1.4 AIM AND OBJECTIVES	6
1.5 SIGNIFICANCE OF THE STUDY	6
1.6 SCOPE OF STUDY	7
1.7 METHODOLOGY	8
1.8 ORGANIZATION OF THE STUDY	8
CHAPTER TWO: _LITERATURE REVIEW.....	10
2.1 INTRODUCTION	10
2.2 DEFINITIONS OF AFFORDABLE HOUSING.....	10
2.2.1 Australia.....	11
2.2.2 United States of America.....	12
2.2.3. Egypt	12
2.3 CONCEPT OF AFFORDABLE HOUSING	13
2.5 DEFINITION OF HOUSING POLICY	14
2.6 POLICIES IN AFFORDABLE HOUSING.....	15
2.7 BARRIERS TO AFFORDABLE HOUSING SCHEMES	17
2.8 DEFINITION OF LEAN CONCEPT	19
2.9 BRIEF BACKGROUND ON LEAN PRODUCTION.....	20
2.10 DIFFERENCES BETWEEN THE LEAN APPROACH AND THE TRADITIONAL PROJECT MANAGEMENT APPROACH.....	21
2.11 THE CONCEPT FROM LEAN MANUFACTURING TO LEAN CONSTRUCTION.....	21
2.11.1 Implementing Lean Manufacturing Techniques to the Construction Industry	23
2.12 THE PRINCIPLES OF LEAN CONSTRUCTION.....	24
2.13 LEAN CONSTRUCTION TECHNIQUES AND TOOLS.....	26
2.13.1 Flow Process.....	26

2.13.2 Pull Approach	28
2.13.3 Continuous Improvement	30
2.13.4 Transparency	31
2.14 BARRIERS TO IMPLEMENTING LEAN CONSTRUCTION CONCEPT ...	33
2.15 ENABLERS OF LEAN CONSTRUCTION	34
2.16 ASSESSING LEAN TECHNIQUES IN CONSTRUCTION.....	36
2.17 LINKAGES BETWEEN LEAN AND AFFORDABLE HOUSING CONCEPT	36
CHAPTER THREE: RESEARCH METHODOLOGY	38
3.1 INTRODUCTION	38
3.2 RESEARCH STRATEGY	38
3.3 RESEARCH DESIGN	39
3.4 STUDY POPULATION.....	40
3.5 SAMPLE AND SAMPLING TECHNIQUES.....	41
3.5.1 Survey Return.....	41
3.6 TYPES OF SOURCES OF DATA.....	42
3.7 METHOD OF DATA COLLECTION	44
3.8 DATA ANALYSIS	44
3.8.1 Quantitative Data Analysis.....	45
3.9 ETHICAL CONSIDERATIONS OF THE STUDY	46
CHAPTER FOUR: RESULTS AND DISCUSSIONS.....	48
4.1 INTRODUCTION	48
4.2 DEMOGRAPHY OF RESPONDENTS	48
4.4 PART B: CONCEPTS AND MEANING OF AFFORDABLE HOUSING	50
4.5 PART C: BARRIERS TO APPLICATION OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES.....	54
4.5.1 Communalities.....	55
4.5.2 Components Loading	56
4.5.3 Discussion of results.....	59
4.6 PART D: ENABLERS OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES IN GHANA	63
4.6.1 Communalities.....	64
4.6.2 Components Loading	65
4.6.3 Discussion of results.....	68
CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS	77
5.1 INTRODUCTION	77
5.2 AIM AND OBJECTIVES REVISIT	77

5.3 EVALUATION ON OBJECTIVES AND AIM OF THE STUDY	77
5.3.1 Objective No. 1 - To assess the perception of stakeholders on the concept of Affordable Housing	78
5.3.2 Objective No. 2 - To identify the potential barriers to the application of Lean Construction Concept in Ghana.....	79
5.3.3 Objective No. 3 - To identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana	80
5.4 LIMITATION OF STUDY	82
5.4.1 Time Limitation.....	82
5.4.2 Cost Limitation.....	82
5.5 RECOMMENDATIONS	82
5.5.1 Recommendations Based on Findings	82
5.5.2 Recommendations for Future Research	83
REFERENCES	84
APPENDIX	93

LIST OF TABLES

Table 2. 1: Definitions of Lean Production.	20
Table 2. 2- Lean Construction Principles and Techniques.	34
Table 3. 1 - Survey Return	44
Table 3. 2 - Method of Data Collection	46
Table 4. 1 - Demography of Respondents	52
Table 4. 2 - Factors Influencing the Concept of Affordable Housing	54
Table 4. 3 - Affordable Housing Defined	55
Table 4. 4 - Respondents' Awareness of Affordable Housing Schemes	56
Table 4. 5 - Test for Sampling Adequacy	58
Table 4. 6 - Loadings on Communalities of Barriers	58
Table 4. 7 - Rotated Component Matrix (Barriers)	59
Table 4. 8 - Factor Loadings of Eigenvalues	60
Table 4. 9 - Definition of Factor or Component	62
Table 4. 10 - Defined Groups of Potential Barriers	63
Table 4. 11 - Measure of Sampling Adequacy	66
Table 4. 12 - Loadings on Communalities of Enablers	67
Table 4. 13 - Rotated Component Matrix (Enablers)	68
Table 4. 14 - Factor Loadings of Eigenvalue	69
Table 4. 15 - Definition of Factor or Component	71
Table 4. 16 - Defined Groups of Enablers	72

Table 4. 17 - Outlines the responses to the respondents' answers of Part D (Section 2) questions 1 – 6.	75
Table 4. 18 - Communalities of Benefits of Lean Construction to Affordable Housing Schemes	78

LIST OF FIGURES

Figure 2.1 – the 5 Guide Principles of Lean	27
Figure 2.2 – Last Planner System	30
Figure 2.3 – Examples of lean tools in construction implementation and suggestions.	35



DEDICATION

This research work is dedicated to State Housing Institutions in Ghana.

KNUST



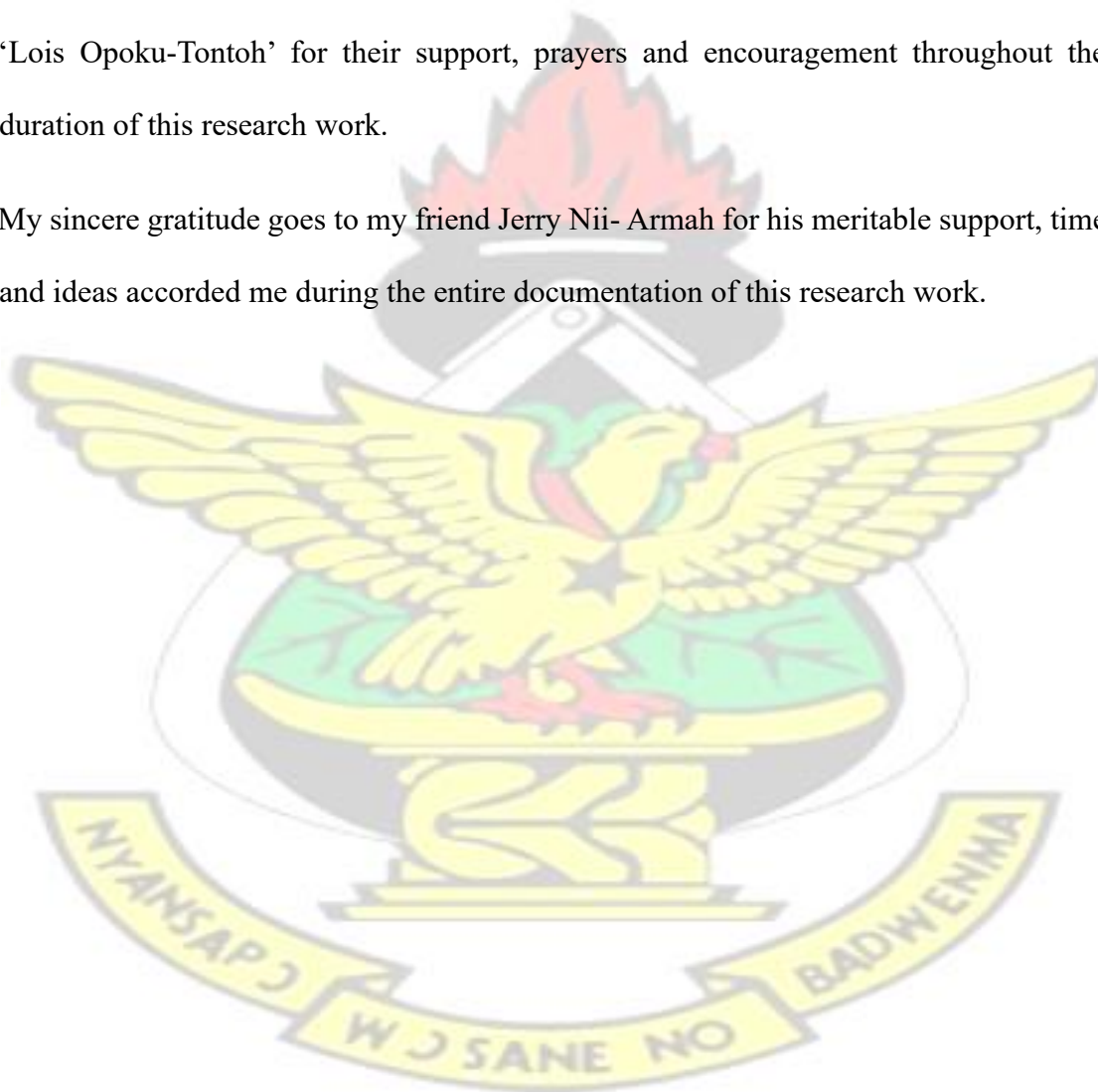
ACKNOWLEDGEMENT

I would like to express my profound gratitude to the Almighty God who gave me the inspiration and strength to carry on throughout my research.

I acknowledge the support from my Supervisor Professor Joshua Ayarkwa and his able assistants Dr. Alex Acheampong and Dr. Kofi Agyekum for their guidance and support.

I would like to express my deepest appreciation to my dad 'Surv. Daniel Kofi Kyere', mother 'Mrs. Comfort A. Kyere, my sisters 'Deborah and Esther Kyere' and my niece 'Lois Opoku-Tontoh' for their support, prayers and encouragement throughout the duration of this research work.

My sincere gratitude goes to my friend Jerry Nii- Armah for his meritable support, time and ideas accorded me during the entire documentation of this research work.



CHAPTER ONE

GENERAL INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Globally, among the urgent tasks confronting governments of today is the provision of affordable housing. Consequently, governments continue to identify and as well plan to address the issue of housing deficit. Governments of some countries such as the US, Sweden and Singapore put into effect various policies to remedy the challenge (UN-HABITAT, 2011). In Wallace's research published in 1995, analyzed the gap in the provision of affordable housing in the United States by focusing on the central fiscal assistance as well as the rule of "for-profit and non-profit" agencies (Malpezzi & Mayo, 1987).

There is not a globally accepted definition of affordable housing; however, there remain a common accepted definition about the group of people target known as the "target group" of affordable housing. Wallace (1995) defines the target group to be the total monthly cost of a family using the United States life cost level, which is less than 30% of the total income of the household. As a result, policies on affordable housing would be applicable (Wallace, 1995).

In the Ghana, affordable housing comprises national construction schemes intended by the ruling administration to make provision for the low-income earners suitable housing facilities. Affordable housing is a significant social, political and economic issue in most emerging countries like Ghana as Boamah (2010) opines. The provision of affordable housing by the Ghanaian government is mostly done through a number of

programmes and other policy initiatives. The weights of these policies differ among political ideologies and they are thus dependent on the incumbent ruling administration.

Housing subventions is one key avenue used by the government in the provision of affordable units of housing (Adjei *et al.* 2015). The effort to provide affordable housing has led to the adaptation of the concept of Lean Construction.

In recent years, the construction industry has to some extent employed the philosophy and principles of 'Lean Thinking' to its product delivery. Lean Construction has attracted interest from the academic and industrial sector since the early 1990s (Green & May, 2005). However, the origin of the lean philosophy started much earlier and it is not possible to describe it without referring the practices and ideas carried out by the Japanese car industry. These practices, inspired by the Henry Ford's theories, were specially developed by a Japanese Automobile company and these were known as Lean Production (Liker, 2004).

The philosophy of lean construction evolved from the lean manufacturing concepts. These concepts focus on the management aspect of construction and ways of improving on the processes of construction in order to meet profitably the demands of the client. Again, lean construction entails the designing as well as the operation aspects including having the appropriate measures, systems and resources with the purpose of delivering the project right on time. One essential aspect of lean construction is its ability to eliminate waste processes and activities that wastes project resources. The main idea of lean construction is to deliver a product that meets client's expectation, by identifying the wastes, understanding the processes to be engaged in the project delivery and eliminating these wastes one after the other (Forbes & Ahmed, 2004).

With increased competition and continuous decrease in terms of profit margins for firms in construction, contractors are on the search for new techniques to increase profit as

waste is eliminated (Mastroianni & Abdelhamid, 2003). Even though a number of different approaches have been established to enhance the effectiveness as well as efficiency of the processes of construction, lean construction however stands out to be the most promising techniques that minimizes or eliminates completely nonprofiting activities on construction sites (Ahrens, 2006). The implementation of these techniques begin with the commitment from the supervisors or the leadership of the project team as its carried on in a culture of incessant improvement for perfection. In cases where lean construction techniques are applied appropriately, far-reaching improvements in efficiency, quality and safety are achievable in the project level.

According to Ayarkwa (2012), if lean construction is adopted in the Ghanaian construction industry, one major benefit will be the reduction of waste as it improves productivity and this could result in the success of providing adequate affordable housing.

Several areas have been identified as linkages between lean and the affordable housing concept. These areas included resource management, waste reduction, value maximization, design optimization, quality improvement, health and safety improvement, performance maximization, resource management, energy minimization, elimination of unnecessary process, and cost reduction (Aziz & Hafez, 2013). Lean and affordable housing share the same goal of waste minimization, value maximization and cost reduction but with different approaches.

1.2 PROBLEM STATEMENT

Affordable housing is a significant social, political and economic issue in most emerging countries such as Ghana (Boamah, 2010). It is therefore not surprising that affordable housing is cardinal to all households and the economic development pursuit

of nations (ibid). Nevertheless, in order to achieve the benefits of this basic good, it needs to be affordable by many households.

The provision of affordable housing by the Ghanaian government is mostly done through a number of programmes and other policy initiatives. The weights of these policies differ among political ideologies and they are thus dependent on the incumbent governing administration. Housing subventions is one key avenue used by the government in the provision of affordable units of housing. Policies such as the establishment of the State Housing Corporation (SHC) and the Roof Loan were put in place for providing low cost housing units in the country (Owusu & Boapeah, 2003).

Previously, the government through the State Housing Corporation (SHC) and the Tema Development Corporation (TDC) controlled planned, allocated and developed land as well as maintained housing estates. The SHC had the responsibility to provide funded housing units and as well to implement government policies and programmes on housing via rental, tenant purchase, rural housing loan schemes, and mortgages (Boamah, 2010).

Empirical works have identified barriers to the provision and sustainability of Affordable Housing Schemes. Among these barriers are the cost of a house, but not limited to, the availability of land, the cost of construction materials and labor, the physical characteristics of a house such as the number of rooms, and the plot size it sits on (Adjei *et al.* 2015).

According to Alinaitwe (2009) and Kpamma (2009), poor co-ordination, low productivity, high costs because of materials wastage, and insufficient quality are found to be among the chronic problems relating to construction. As Begum *et al.* (2006) and Polat *et al.* (2004) opines, research identifies the cause of high level of material wastage in the industry construction to be attributed to delays, inefficiencies, poor communication and negligence.

As a result of the complexities and rapid advancement of the construction industry, there is an urgent need for construction systems and models to solve complex problems. Through the development of models and systems, parties to a project would be better equipped to achieve project targets by meeting the budget, completing the project on schedule, improving quality and maximizing return.

With the rise in investment in residential projects, one would expect many units to be available to accommodate the increasing demand for housing. Despite this high spending in real estate residential projects, fewer units are made available as developments are being directed towards luxurious properties for the wealthy. However, housing affordability is still a pressing matter that needs attention (Anuta , 2014).

Proactive management approaches are under research to equip decision makers and project parties with the necessary tools to solve the shortage of housing units. Measures have been put in place to minimize the cost of affordable housing through prefabrication, modular construction, economics of scale and low material cost (Lafarge, 2010). Extensive research has covered most aspects related to affordable housing and structural optimization. However, not much literature is found on implementing lean concept to the achievement of affordable housing schemes. Thus, there is a gap and the need for a research in this regard.

1.3 RESEARCH QUESTIONS

1. What are the perception of stakeholders on the Affordable Housing Concept in Ghana?
2. What are the potential barriers to the application of Lean Construction Concept to Affordable Housing Schemes in Ghana?

3. What are the enablers to the implementation of Lean Construction Concept to the execution of Affordable Housing Schemes in Ghana?

1.4 AIM AND OBJECTIVES

1.4.1 Aim

This study is aimed at identifying and assessing the enablers of lean construction to the execution of Affordable Housing Schemes in Ghana.

1.4.2 Objectives

- 1) To assess the perception of stakeholders on the concept of Affordable Housing;
- 2) To identify the potential barriers to the application of the Lean Construction Concept in Ghana; and
- 3) To identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana.

1.5 SIGNIFICANCE OF THE STUDY

This research seeks to:

Define the Affordable Housing concept and its implementation in some countries;

Establish the linkages between lean and affordable housing scheme;

Identify principles relating to lean construction that most firms in the industry engage in their activities like establishing incessant improvement; delivering project to meet client's requirement; constantly pursuing ways of reducing waste and avoiding defects, these when implemented would result in reduction of total construction cost of the Affordable Housing Units in Ghana.

In addition, the application of lean thinking to affordable housing schemes would reduce time used in correcting mistakes (rework) as it seeks to achieve accuracy. Since production errors are avoided, the project would be executed within the stipulated time.

Furthermore, the drivers and enablers of lean construction concept would lead to

- a) An enhanced understanding as well as knowledge on implementation factors that relate with lean construction;
- b) senior managers commitment and support; and
- c) Adoption of a continuous improvement culture.

The results of this study would provide prospective solutions that would assist in implementing effective lean construction concept in the affordable housing scheme in Ghana. Consequently, these findings should offer in the long term an economic benefit to firms in the construction industry through the maximization of resources as well as guarding the future of the Affordable Housing Scheme. The adaptation of the findings of the study will be of value to the government, stakeholders and construction firms looking for ways to enhance work quality and productivity of Affordable Housing Schemes through the adoption of the lean thinking approach.

1.6 SCOPE OF STUDY

The scope of this study focuses on examining the literature obtained from primary and secondary sources pertaining to the research question to identify potential barriers hindering Lean Construction implementation in Ghana and the possible enablers and drivers required to implement lean construction concept to the execution of Affordable housing Schemes in Ghana.

This research is limited to the perception of Construction Professionals (Quantity Surveyors, Project Managers, Architects, Engineers and Procurement Managers) within the Greater Accra region of Ghana on Affordable Housing Schemes and their knowledge of the lean construction concept.

In anticipation, this study will spawn interest from sustainable development researchers and other interested agencies since the study will deliver rudimentary elements in the direction of a more rigor lean implementation.

1.7 METHODOLOGY

First, germane literature relating to the theme of this study was reviewed. The quantitative approach was used for the study. This research adopted the positivist models to be its major philosophical stance after a consideration of the axiological, ontological and epistemological positions. After the existing literature had been reviewed, it aided in developing a survey questionnaire which focused on the aim and specific objectives. The Likert scale system of rating was used for the questions in the questionnaires. The purposive sampling technique was employed. The data collected were analyzed using the Statistical Package for Social Sciences Software (SPSS v20.0) using Factor analysis; Kaiser Meyer Olkin test, Bartlette's test of Sphericity to test the reliability and adequacy of the sample of factors studied.

1.8 ORGANIZATION OF THE STUDY

The research's design is organized into five interrelated chapters. The chapter one makes the introduction of the study as it outlines the study's background with the inclusion of the research aim and objectives, problem statement, research question, and scope of the research. The chapter two reviews pertinent literature connected to the research including the definition of Affordable Housing, Benefits of Affordable Housing, Policies in Affordable Housing, Barriers in Affordable Housing, Brief background on Lean Production, The Concept of Lean Construction from Manufacturing, Implementing Lean Manufacturing Techniques to Construction etc. Chapter three elucidates the methodology chosen. This will tackle sample size determination, research philosophy, sampling techniques, sample population, statistical tools, and questionnaire design and administration. The chapter four is the results and

discussion of data gathered. The chapter five being the last chapter the study wraps up the whole research as it reviews the foremost contributions of the study to the body of knowledge.

KNUST



CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The chapter one presented the study's background; problem statement; research aim and objectives; the research scope; and the significance of the study. This helped to put the subject of the study into perspective. This very chapter makes presentation of reviewing pertinent literature pertaining to the research questions. It includes the definition of Affordable Housing, Benefits of Affordable Housing, Policies in Affordable Housing, Barriers in Affordable Housing, Brief background on Lean Production, The Concept of Lean Construction from Manufacturing, Implementing Lean Manufacturing Techniques to Construction, Lean Construction Tools and Techniques among others were elaborated in this chapter.

2.2 DEFINITIONS OF AFFORDABLE HOUSING

A clear-cut definition of "Affordable housing" does not exist even though there are several opinions by researchers to the term affordable housing. Some researchers defined affordable housing as the housing that median income residents may afford according to their country and region (Bhatta, 2010). According to Milligan *et al.* (2004), the main idea behind affordable housing is to provide quality housing units that meet the needs of the low and middle-income households without assistance. Affordable housing describes the housing system that aids the lower income earners or households to obtain and pay for the appropriate housing unit devoid of undergoing any financial hardship. Milligan *et al.* (2004) stated that, the various private or publicly introduced forms of housing possibly would meet the aforementioned specification. Actually, affordable housing as a term in this recent years has been used interchangeably as 'social', 'low cost' or 'public' housing (Gabriel *et al.* 2005).

According to O'Del *et al.* (2004), the definition of 'affordability' which is considered as the standard, refers to the payment of not more than 30 percent of a household's income for housing with the inclusion of utilities. The US Department of Housing and Urban Development (2012) reported that households like the low-income ones find it difficult to pay for other non-housing needs like childcare, clothing, food, transportation etc. as the 30% is applied to all households be it low or high income group. As the RICS reported, affordability in relation to urban housing refers to the 'provision of enough shelter' on a continuing basis which also ensures tenure security in the course of common metropolitan household.

Also the definition of affordable housing according to the Ethiopian journal of Environmental Studies and Management refers to the housing that includes the complete gamut of factors of the environment that render living comfortable and acceptable. According to Boamah (2010), they include ventilation, good access routes, access to basic human needs like water etc. and sanitation.

The under listed are some geographical definitions of the Affordable Housing Concept:

2.2.1 Australia

In Australia, affordable housing is defined as the housing that low or middle-income households could afford without affecting their ability to sustainably meet other basic needs. They further clarified that housing should have a reasonable location with an acceptable standard for residents. The target group is seen to be families or households with relative income equivalent to the bottom 60% in the household income distribution. It should be noted that the lowest group, bottom 20%, are usually renters or retirees who have already invested in the home many years ago. For households within the 20-60% income brackets, housing affordability declined (O' Del *et al.* 2004). Some invest in a house while others rely on rental accommodation so as to meet other costs of living sustainably. Investments in housing for the rich, upper 60-80% and

80100%, yields higher return (*ibid*). This encourages private investors and real estate developers to target the wealthy. Private investment for the wealthy is sufficient to meet the demand thus there is no government intervention in this sector. On the other hand, the demand for housing by low-income and middle-income households is not sufficiently met and thus the intervention of the government is a must to stimulate the affordable housing market (Australian Council of Trade Unions, 2007).

2.2.2 United States of America

The US Department of Housing and Urban Development (HUD) considers affordable housing as the housing in which low or middle income households would be able to afford with no more than 30% of their income. A report by HUD identified the major barriers to affordable housing to be either within government control or beyond the government control. Factors affecting housing affordability are construction costs, development regulations, financing, lack of jobs and legal issues. Several initiatives have been proposed for revamping regulations, offering simplified financing programmes and long-term loans, availability of jobs in proximity and introducing new laws to help curb the need for affordable housing. The construction cost is composed of the land price, labor, equipment and materials costs. The cost of land is usually related to the regulatory rules that are in place and the governmental policies that regulate land prices. Affordable housing land prices are not usually correlated with the demand of housing. It is rather somehow subsidized by governments in an effort to assist low and middle income households acquire affordable homes (UN-HABITAT, 2011).

2.2.3. Egypt

The Egyptian law defines low-income housing as housing that households earning 30,000 EGP or less per year can afford. The definition of affordable housing is as per the Egyptian law according to article 1 of Prime Minister Decree 1864 of year 2008, which is an update on article 35 of mortgage law 148 of year 2001. This definition is

not accurate seeing that two-thirds of the Egyptian workforce are not formally employed with contracts and insurance. The current loan to income ratio that the government is offering for the social housing project is 35%, which is a risk to households living at the upper poverty line. Furthermore, the definition of low-income housing being households with 30,000 EGP annual income includes the highest income quintile. Thus, higher social classes will be competing with lower social classes for the offered units. Housing prices and current income levels are not increasing proportionally. Rather, the housing prices are booming while income levels are relatively stagnant. The issues associated with housing in Egypt are rather related to governmental policies, regulations, unhealthy bureaucracies and lack of adequate housing (Egyptian Center for Economic & Social Rights, 2014).

2.3 CONCEPT OF AFFORDABLE HOUSING

According to Adjei *et al.* (2015), affordable housing includes the complete gamut of factors of the environment that render living comfortable and acceptable. According to Boamah (2010), they include ventilation, good access routes, access to basic human needs like water etc. and sanitation. Affordable housing thus involves a family's ability to meet other basic needs of life like clothing, food and accessing enough housing. Housing affordability again includes a household's ability to consume a unit of housing that enhances mortgagors to successfully meet mortgage requirements; allows reasonable standard of living; and allows families to access the required standard of housing not denying them from accessing other basic needs of life (CHF International, 2004).

From country to country, it noted however that, the average standard of housing differs specifically countries with different economic and geographic conditions. According to Boamah (2010), the standards that are acceptable, rise with what is included in the homes as well as income levels. The provision of affordable housing over some years

now has been delivered in two foremost channels. The first one is the delivery or provision of affordable housing through the encouragement of research into the use of local building materials like tiles, bamboo, compressed earth bricks etc. The second one forms the most popular means that deals with the construction of low or affordable housing by other private agencies and government subventions (Nsiah-Gyabaah, 2013).

2.4 BENEFITS OF AFFORDABLE HOUSING

The advantages of affordable housing are tremendously massive to all countries. It enhances the political, economic and socio-economic life of the people; it makes available shelter that serve as a shield against bad weather conditions as well as other hazards; it impacts significantly the growth and productivity in a country; and it impacts stability and efficiency the economy in general and the financial market as well (Boamah, 2010). Affordable housing is a significant social, political and economic issue in most emerging countries like Ghana. It is however not astounding to mention the delivery of quality affordable housing as an essential thing to virtually all households as well as the economic development of countries. Nevertheless, in order to achieve the benefits of this particular good, the affordability of it must be taken into consideration (Boamah, 2010).

2.5 DEFINITION OF HOUSING POLICY

Housing policy was defined by Agbola and Alabi (2000) as the statement of aim, ideas and plan of action. Housing policy therefore forms a guideline that is provided by the governing administration as it is aimed at addressing the need and the demand of housing by the people engage sets of apposite strategies like regulatory, institutional, fiscal and legal frameworks (Agbola, 1998). Housing policy thus provides a framework that sets goals and defines action but it does not essentially postulate any distinct strategies that would be engaged to achieve the goal but board strategies.

2.6 POLICIES IN AFFORDABLE HOUSING

As cited in Boamah (2010), most housing in Ghana is built by the citizens themselves as they engage local contractors to undertake such housing projects on their own lands acquired through the local chiefs under the customary ownership. Differently, authorized housing policy together with its official enactment are centralized tasks of the country that pays little attention to the needs of the local people (UN-HABITAT , 2006). In earlier times, that is, before the year 2000 Housing and Population Census that established the nature as well as the scale of stock of housing in this country, the formulation of housing policy hinged on unsophisticated and mutable estimates that depended on the link between houses and households in the context of decreasing crowding. Little concern was shown to effective demand as it considers the capacity of prospective legatees to pay for housing. Additionally, Boamah (2010) cited that housing conditions in just Accra and Kumasi have subjugated the attention of policy makers.

Policies that affect housing are those policies that are made by ministries that take into consideration their own way of viewing the world and seen to be lacking co-ordination between them. Furthermore, policies and regulations on housing ceased the use of local materials especially those that were earth-based and planning policies and regulations virtually banned what is called compound houses. These acts affected the provision of affordable rental housing to the low-income groups at the time that they were needed. There are three basic National Policies on Housing; the 1986 Housing Policy overly involved partially because of a proposal to establish a fund for the policy with obligatory contribution from the country and taxes acquired from the importation of building materials. The 1992 National Shelter Strategy that was developed with the support of UN-HABITAT overly involved after the policy has been sent to cabinet for it to be approved, partially because the motivation for the initial policy had substantially

weakened. An assessment of the policy was commissioned with the use of consulting team in the year 1999 and it was completed in the year 2000.

After five years, the government introduced again additional round of assessments that was supported by UN-HABITAT by means of a task team method. This particular review still persist as the whole processes have been completed before any submission is made to the Cabinet for it to be approved. Inside this report, the ministry in charge of Water Resources, Work and Housing considers the Sector of Housing to be significant in the establishment of the standard conditions of the sector of housing (UN-HABITAT, 2011).

The provision of affordable housing by the Ghanaian government is mostly done through a number of programmes and other policy initiatives. The weights of these policies differ among political ideologies and they are thus dependent on the incumbent governing administration. Ghana has policies that have been set aside to govern the housing system (UN-HABITAT, 2011).

After reviewing various literature, the following are some of the housing policies that would help to determine some policy forms that applies to the affordable housing concept:

- Tax policy;
- Housing finance / mortgage Policy;
- Construction Policy;
- Promotion of Real Estate Development Policy;
- Land Policy;
- Rent Policy (Asamoah, 2014; UN Habitat, 2011; Andreasen *et al.* 2005; Ferguson and Navarrete, 2003).

2.7 BARRIERS TO AFFORDABLE HOUSING SCHEMES

Many factors affect affordable housing provision including cost of a home, but not limited to, the availability of land, the cost of construction materials and labor, the physical characteristics of a house such as the number rooms, and the plot size it sits on. Neighborhood characteristics such as whether or not a home is part of a homeowners association (Buss, 2011). Notwithstanding Construction costs that largely determine housing affordability, certain regulatory tools affect the different components that make up total construction costs, which in turn impact housing affordability (Adjei *et al.* 2015). Barriers in the provision of affordable housing have increased in many years; different approaches have been adopted in relating to housing development projects serving average income households to solve these barriers.

Land cost and availability: Land is a key factor of production. Its access is critical as it includes a momentous proportion of the entire cost of financing acquisitive shelter construction procedure and again access to cheap land is important in making the progressive shelter development procedure feasible (Payne, 2002). The availability of land is actually limited and it is again coupled with the need for it for low cost housing, rendering it scarce. As a result, there is an increase in the numerical class of people whose access to shelter and land are daily becoming difficult especially in the urban communities. According to Chepsiror (2013), it is a fact because some years ago, lands were easily acquired even the low-income households, but the situation is not the same now (Chepsiror, 2013). The cost of land depends on factors such as location, institutional and health facilities, service and amenities, availability of public transport, nearness to commercial areas etc. (Sila & Olweny, 2014). In Ghana, the chiefs own lands although the government can possess it in the interest for national development.

Construction costs: In the most general terms, “housing finance is what allows for the production and consumption of housing” (King, 2001). It includes money to build,

maintain, rent, pay loans or mortgages, and manage dwellings. Housing finance exists to make good quality housing affordable to everybody, and this is ultimately why governments (local, state and national) are involved in the housing system (Martel, 2013; King, 2001). Gap does exist between the sale price of housing and the actual cost of building housing which majority of houses were sold at near their construction costs, there are areas of the country with unusually expensive housing costs (Buss, 2011; Glaeser & Gyourko, 2003).

Lack of a jobs-housing balance: The location of housing and jobs has thoroughly shifted for many Ghanaians. Certain areas within a community are more valuable because of their proximity to good schools, jobs, amenities, and parks and open space (Martel, 2013; Buss, 2011). Katz and Allen (1999) opined that the citing of affordable housing address the proximity of jobs of residence and their homes. The diversity requires that regions and cities take a closer look at the socio-economic situation of the residence and respond reasonably to their unique situation. (Katz & Allen, 1999).

Development regulations: Certain land use controls has effect on housing available at prices affordable to the average income person or increase the cost of shelter without offsetting public purpose which results to a large lot zoning practices. These range from the minimum plot sizes that promote larger and more expensive homes to multi-family residential home insurance. Some communities, regulations set a new development and construction costs by 35%. A 2005 follow-up report by HUD, established that the more heavily regulated areas of the lease was 17% higher; home prices 51% higher; and home ownership rate of 10%, respectively, compared to less regulated areas. Impact fees and inclusionary zoning is particularly expensive. If these costs were reduced, housing would be more affordable.(Franko, 2009; Laquatra & Potter, 2000).

2.8 DEFINITION OF LEAN CONCEPT

The term 'Lean Production' was first used in a book published by Womack titled "The Machine that Changed the World - The Story of Lean Production". The book accounts the drive from the crafty production of automobiles in manufacturing to a large assembling by means of Lean production. The book recalls the standardization and assembling of automobile parts so that semi-skilled employees and machine parts could produce inexpensive car for the many by Henry Ford.

Currently, various definitions of lean production exist in literature. Ong (2002) compiled a list of lean production definitions as displayed in Table 2.1 below:

Table 2. 1: Definitions of Lean Production.

Author	Definitions
Womack and Jones (1994)	By eliminating unnecessary steps, aligning all steps in an activity, and continually striving for improvement
Womack and Jones (1996)	System that can reduce overall cost especially indirect cost while maintaining quality standards and reducing manufacturing cycle time
Howell (1999)	Design a production system that will deliver a custom product instantly on order but maintain no intermediate inventories
University of Alabama (1999)	An approach to identifying and eliminating waste (non-adding value activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection

Caroll (2011)	Is the philosophy of eliminating all waste in all system process continuously
The School of Labour and Industrial Relations, Michigan State University (2001)	Is a system of work organization that strives to deliver high quality, low cost products through the efficient use of resources and the elimination of waste

Source: (Ong, 2002)

Achieving a balance use of resources, materials and people is the goal of the lean philosophy. This enables organisations and firms to eliminate waste, reduce cost and deliver projects on schedule.

2.9 BRIEF BACKGROUND ON LEAN PRODUCTION

The concept of lean production sourced from the manufacturing industry of Japan precisely a young engineer called Ohno from the Toyota Production System (TPS) (Holweg, 2007). The TPS was first introduced after the Second World War by Japan when the country required the production of small cars in various types different from the Ford method of producing in bulk (Conte, 2002). It was however, decided by Toyota that the bulk production of cars was no longer effectual, particularly after drop down in sales which hit the Japanese company that year leading to laying off many workers of the company. Therefore, Toyota company developed novel designs and incorporated the Toyota Production System referred to as the 'Lean Production System' (Ahrens, 2006). The objective of the new Toyota concept referred to as 'lean production' was to improve productivity through high quality production with best value and at less cost. The system was focused at achieving a consistent flow of production to lessen inventories. Essentially, the system was accomplished through the elimination of activities that add nothing to the ultimate product, namely waste, which according to Conte (2002) attained a system that rendered Toyota outstanding levels of performance. Lean manufacturing employs all the techniques involve in lean to constantly identify

and eliminate wastes inside the system. According to Howell (1999), Lean production system aims at meeting the needs of a customer through instant delivery of product without intermediate inventories.

2.10 DIFFERENCES BETWEEN THE LEAN APPROACH AND THE TRADITIONAL PROJECT MANAGEMENT APPROACH

The lean concept forms a different approach in managing construction projects. It is very effective on projects that are complex or fast track and possess very high uncertainties. According to Sicut (2012), there exist a number of dissimilarities considering the traditional project management and that of the lean construction approach. Sicut (2012) cited the following differences in literature:

- “ whereas lean construction approach aims to ensure consistent workflow, traditional project management considers corrective action once variances are detected;
- “lean approach targets mainly the maximization of value through perking up the entire process as the traditional method targets value optimization for an activity independently”;
- “ whereas lean approach is ‘pull-driven’, the traditional method is ‘pushdriven’; and
- “one of the major aims of lean approach is to reduce variations at the early stages; the traditional approach does not consider that”.

2.11 THE CONCEPT FROM LEAN MANUFACTURING TO LEAN CONSTRUCTION

Processes inside the industry of construction are turning to be more multifaceted and as a result rational management method ought to be developed to address the chronic difficulties as well as problems facing projects. According to the Lean Construction Institute (LCI), Lean Construction refers to “a project management based method to the delivery of project, build capital, and a way to design facilities”.

Having witnessed a tangible improvement in manufacturing implies that applying lean production principles to construction will change its way of executing task using the delivery process. Minimization of waste and maximization of value is the prime purpose behind lean system of production by the appropriate application of the lean techniques. Irrespective of the distinct dissimilarities concerning the features and structures of manufacturing and construction, the pursuit of principles and common goals are mutual to both. Both construction and manufacturing organizations work to achieve system optimization by using collaboration, progressive enhancement in production, focusing on satisfying customers, workflow that focus on eliminating obstruction and non-added value and realization of a production pull.

Engaging the technique of lean production to construction activities causes challenges because of a vast difference in terms of the physical qualities or features of the final product of construction and manufacturing. According to Salem *et al.* (2006), site production, complex difficulties, and unique production are among the features that differentiates manufacturing from construction. Earlier research describes the aforementioned features as: On-site production: In construction, manufacturing is undertaking on site as installation as well as erection are done at the final site which results in the creation of valuable production. Furthermore, the contractor is to ensure an excellent standard for the erection of the constituents on the construction site, which ought to resist the site conditions (Koskela, 1992). The rate at which products are customized in construction differs from that of manufacturing as clients play key task in terms of customization or change during the course of the lifecycle of a particular project. On the other hand, retailers standardize products in manufacturing due to the adoption of the use of specialized machines or equipment giving limited room for customization. Koskela (1992) described the Construction process as complex due to its complicated processes, unique and dynamic nature of each project in that every

project becomes a different task escorted by dissimilar ideas and resources as well as preliminary design with varying specification (Koskela, 1992). In contrary, manufacturing optimize its production process by the use of specific facilities that have the right technology affording a consistent product flow as Salem *et al.* (2006) opines. Due to the above discrepancies, it pose many hesitation and hesitations in the process of production. Conditions such as climate and soil, coordination between different trades and the frequent change in customers are some of the uncertainties in the construction project effecting the project cost and time.

Zimmer (2005) stated that, in spite of the distinctions between Manufacturing and Construction industries, the two still aim to distribute a competitive product in a set period with the maximum quality and value and a less cost. Given the above-mentioned similarities, then the application of Lean production in the industry of construction ought to be considered. Nevertheless, both industries have their own ways of achieving the objective of Lean.

2.11.1 Implementing Lean Manufacturing Techniques to the Construction Industry

The Lean principle is resolute through the application of pertinent techniques to the actual undertakings in the process. Manufacturing, supply and design form the fundamental undertakings of lean organization as Salem *et al.* (2006) opines. According to Salem *et al.* (2006), the goals behind these principles as outlined by the TPS include people development, quality assurance and reducing cost so to sustain growth of the system.

The Toyota Company among the Japanese manufacturers' came out with the principle of lean production. According to Liker (2004) there are fourteen (14) principles creating way for the Toyota company which he organized them into four broad categories referred to as the 4Ps: 1) Developing People or Partners, 2) Philosophy, 3) Tackling Origin of Problem and 4) Right Process yields Right Results (Liker, 2004). Continuous improvement of

process within an Organisation is the Toyota Way. Principally, reduction in waste generation by reducing non-value added activities is the concentration of Toyota Production System (TPS). They detected seven prime types of waste of which Liker added another making it eight in all. The eight identified waste types are defects, over processing, over production, excess inventory, waiting, unnecessary movement, unnecessary transport, and unused employees (Liker, 2004). In the effort of Koskela and Howell in the introduction of a new conceptual model revealed the gaps in the current planning, execution and control models. They stated in their conclusion that the Traditional tools presented in the PMBOK was not successful in delivering projects at the agreed budget, time and quality; they added again that the tools failed in managing project-based fabrication schemes.

The International Group first introduced the term “Lean Construction” in 1993 during their maiden meeting held by the Finnish Lauri Koskela (Gleeson, 2007; Ballard & Howell, 2003) and Lean Construction Institute (LCI) designed the system of lean project delivery. Ballard (2000) stated that the basic purview of the Lean Project Delivery Systems (LPDS) is the project-based production system. Ballard (2000) classified Lean Project Delivery Systems into four modules: lean assembly, lean design, project definition, and lean supply. Transparency, Continuous Improvement, Flow Variability, and Process Variability are among the techniques of lean production presented in literature (Salem *et al.* 2006). Countries like the US, UK, Australia, Venezuela, Singapore, Finland, Chile, Denmark, Korea, Brazil, Peru, and Ecuador are all incorporating the concepts and techniques of Lean Production in their construction industries (Ballard & Howell, 2003).

2.12 THE PRINCIPLES OF LEAN CONSTRUCTION

Change in the work structure in both design as well as building in order to take full advantage of project performance is the sole aim of tackling projects as production systems (Howell and Lichtig, 2008). According to Enache-Pommer *et al.* (2010)

Principles of Lean focus on the optimization of the whole process of production through waste eradication, improving continuously, collaboration as well as satisfaction of customer by handing the end user's wanted value. From Sacks *et al.* (2009), Lean Construction application discerning to the system of production on site has heightened the consciousness of the advantages of constant work, of materials to reduce inventories of progress work as well as pull flow of teams, together with transparency process to all involved. Lean construction focus is to prevent defects (Salem *et al.* 2006). The following are the five (5) prime principles of Lean method of production as originally outlined by Womack and Jones (Bertelsen, 2002):

- a) **Customer value identification** – it is of great importance to bring satisfaction to a customer by meeting the required specification and value. Therefore distinctly value defining for services or product, the value of customer turn into the mutual target for players on the project.
- b) **Stream value mapping** – these techniques focus on operations that generates value. It is the measures between the entire process required to make available a service or product as well as the degree to which customer value is met. It represents the end-to-end process of delivery by reducing non-value added activities.
- c) **Make the product flow, wait is waste** – this is the maintenance of good flow of work in order to actualise the greatest of work sequence. The sequential flow of work whereby the service or product at no time stop across the whole value chain will concurrently minimise waste as well as increase customer's value.
- d) **Usage of Pull Logistic** – this is the production of services or production in accordance to the demands of customers, meaning what the customer is looking for and when the customer wants the product or service.

- e) **Seek out Perfection in all Processes** – this is to pursue perfection at all time by improving the process continually and by the implementation of right approaches to the process.

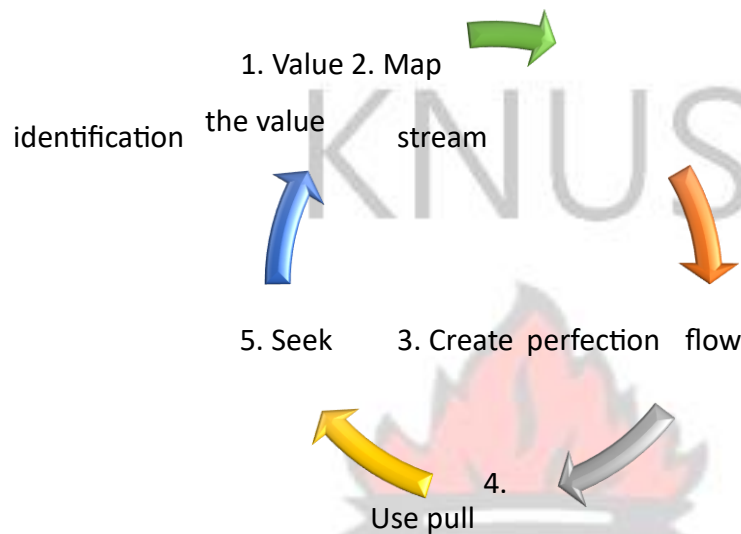


Figure 2.1 – the five (5) Principles of Lean (Bertelsen, 2002)

2.13 LEAN CONSTRUCTION TECHNIQUES AND TOOLS

Lean production principles affords many tools and techniques which when applied in the construction industry can be used to improve its performance to effect efficient process in the pre-construction, construction as well as the post-construction phase of a project (Mostafa E. Shehata, 2011; Salem *et al.* 2006). Lean tools and techniques are briefly described as follows;

2.13.1 Flow Process

According to Yong-Woo Kim and Bae (2010) lean construction system perceives production as information, labour, equipment, as well as material flow from raw material to the product. The stable flow is well thought-out to be one of the key ethics in the lean thinking (Sacks *et al.* 2009). Numerous lean practices are employed to advance the flow process as well as reduce waste. These techniques consist of but then again not limited to the following:

2.13.1.1 Process Variability Reduction

According to Hook and Stehn (2008), building projects are exposed to frequent changes throughout the length of the projects' lifecycle leading to variability as well as uncertainties in the process. Certain activities should be taken to prevent blemishes at the source so they do not overflow the process in order to avoid variability in the process. According to Salem *et al.* (2006) in lean manufacturing, reliable devices are employed to avoid flaws from moving to the next course. Until now, building this method was difficult as a result of the complexity in discovering defects before installation. To safeguard excellence, conformity to reliable activities can be executed on every activity on site to prevent variations. According to Salem *et al.* (2006), these activities can be obtained by devising a complete quality assessment as well as safety action strategies at the start of the project.

2.13.1.2 Reduce Cycle Time

Sacks *et al.* (2010) stated that "Variability reduction will lead to work cycle time reduction. Cycle time reduction in construction is characterized by activities duration reduction as well as inventory reduction". This requires team effort to restructure the progression to make it more efficient and flexible.

2.13.1.3 Batch Sizes Reduction

According to Sacks *et al.* (2010) reducing the batch size increases the flow of work. Similarly, it underwrites in reducing the cycle period of the process.

2.13.1.4 Increase Flexibility

This could be achieved by engaging multi-skilled players in the process flow. The productivity rates is increased by reducing changeover time to move from an activity to the next (O'Connor and Swain, 2013). Further, Sacks *et al.* (2010) advocated that, employing multi-skilled teams likewise assist in cycle period reduction as well as advancing the workflow.

2.13.2 Pull Approach

The utmost important as well as imperative lean method features is adopting the pull planning as a suitable approach. According to Thomas *et al.* (2003), the most decisive lean techniques to advance workflow in Building projects is pull scheduling. From Sacks *et al.* (2009), the flow is an approach of monitoring product flow in which the extent of ‘Work In Progress Inventory’ (WIP) between process stages is reduced, plus only products demand “pulled” by ultimate “customer” process are formed in pull system.

2.13.2.1 Last Planner System (LPS)

The Last Planner System is a construction scheduling/planning system constructed to give out expected rapid learning programming and workflow, building and commissioning of projects and design. This is one of the related techniques to the pull method, since it assist the reliability as well as the predictability of building production in which “look-ahead” planning is employed. With the last planner, it is basically the supervisor on the field who allocates work to the team because it permits the discussions among the trade foreman as well as the site management correct level of detail avoiding serious matters on site to occur. According to Mossman (2012), Last Planner System is a cooperative strategy to achieve project-based production of multifaceted indeterminate plans, permitting difficulties to be known as well as determined at the basis to improve the chance that work flows with no interruptions. Consequently, Mossman (2012) opined that the Last Planner System practices in building comprise processes in design, tender process managing, as well as design and building production in the setting of combined delivery of project. According to Zettel (2008) the Last Planner System processes are shown in figure 2.1 below:

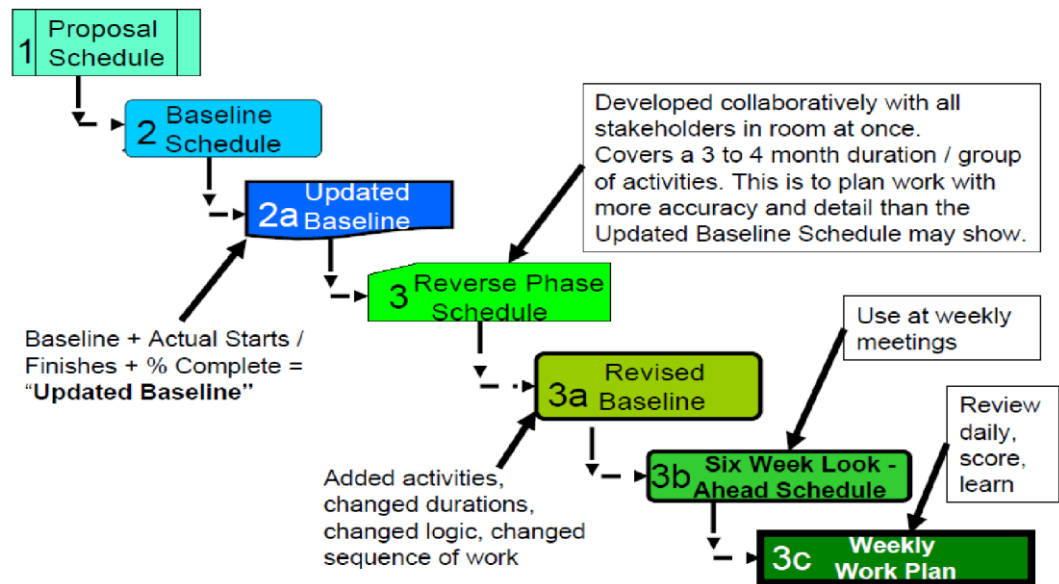


Figure 2.2 - Last Planner System (Zettel, 2008)

2.13.2.2 Just in Time Technique

A report by Australia (2012) simply put just in time as creating only what is required or wanted, when it is required, as well as in the quantity required. Thus, it is a Pull system that answers to definite demand of customers also primes to lessen inventories as well as good equipment efficiency.

2.13.2.3 Collaborative Planning

This practice rest on gathering representatives from various parties involved with the building project to cooperatively come up with an approved target programme. It may be practically employed at different points in the project life cycle to get any cost or time overrun that possibly could happen. It includes five steps:

1. increase in collaborative master target program level;
2. complete level collaborative master target programme;
3. short term complete plan of production;
4. regular brief and
5. control of weekly production.

Efficiently implementing a collaboration concept can be achieved through the

Integrated Project Delivery (IPD). The American Institute of Architects (AIA) defined Integrated Project Delivery (IPD) as “an approach of delivering project that assimilates individuals, the structure of business, systems as well as practices into a process that collaboratively binds the aptitudes together with the understandings of every individual to minimize waste plus efficiency optimization by all design stages, fabrication as well as building” (Dave *et al.* 2013).

Integrated Project Delivery (IPD) permits the early participation of all participants in the project by the adoption of emerging technologies. One of the basic ethics of Integrated Project Delivery (IPD) is benefits sharing plus risks among all stakeholders. However, all these advantages are attained if it is characterized by an Integrated Project Delivery (IPD) legal agreement (Dave *et al.* 2013).

2.13.3 Continuous Improvement

According to Sacks *et al.* (2010), improving continuously can assist in minimizing variations as well as workflow improvement. Thus, the continuous improvement principle is supported by the lean techniques. Furthermore, continuous improvement of the building procedure can be grouped into two forms: ‘Operation Improvement’ and ‘Process Improvement’ as opined by (O’Connor and Swain, 2013).

2.13.3.1 Improvement in Process

Improving process denotes efficiently setting means to complete a project to advance the total procedure in by minimizing the total lead-time from end – to – end course.

According to O’Connor and Swain (2013), in implementing this technique, the major advantages are e work productivity improvement, process as well as roles clarification, and reduce lead-time and minimize waste (O’Connor & Swain, 2013). Methods that are connected to this technique are: 1) establishment of current state map (CSM) to display the present process of the project as well as delays, interruptions together with any other wastes; 2) future state mapping (FSM) establishment to established a process integrating all the suitable lean techniques in that, the work will flow efficiently

(O'Connor and Swain, 2013).

2.13.3.2 Operation Improvement

This is wholly advancing the work activity process of implementation. Improving operations seeks to minimize the time cycle to accomplish improve productivity, work activity, consider right first time quality and safely support working by eradicating nonadded value events, controlling and monitoring performance as well as optimizing resources (O'Connor and Swain, 2013). Controlling and monitoring performance by setting procedures related to time, quality, cost as well as safety to effectively regulate the process (O'Connor and Swain, 2013).

2.13.4 Transparency

Salem *et al.* (2006) categorized the following under transparency:

2.13.4.1 The Five S'

This was presented in business to identify housekeeping in plants as in lean manufacturing. Unproductive performance as a result of inefficient deployment of resources is viewed as waste that should be removed from the system according to Salem *et al.* (2006). The 'Five S's' are namely; *Straighten, Sort, Shine, Standardize* and *Sustain*. In building, employing this tool (5S's) permit for a see-through job site, at which material flow proficiently between pertinent jobs in site and the warehouses.

2.13.4.2 Visual Management

In construction process, visualization is significant to avoid any information ambiguity. From Salem *et al.* (2006), it assists in identifying the workflow as well as creating responsiveness of on-site action plans. Thoroughly, the visualization process can contribute in helping the lean practice in building if employed in a style suitable to the situation. The practice comprises displaying the status of completed work, work in progress, material availability, layout changes as well as other resources locations. Undertaking the previous steps can effectively advance production planning/scheduling

and control as well as minimize the propensity for errors within the course as Sacks *et al.* (2009) advocated. They further stated that, Safety signs, notice boards electric wiring, Mobile signs, project milestones as well as ‘Planning Programming & Coordination’ (PPC) charts are some of the visualization forms that can be employed in building projects.

KNUST

Table 2. 2- Lean Construction Principles and Techniques.

Lean construction principles	Technique	Methodology
Flow	Reduce variability fail safe for quality reduce batch size Reduce cycle times increase flexibility	Get quality right the first time (reduce product variability) Reduce production cycle durations reduce changeover times use multi skilled teams
Pull	Use reliable technology Last planner collaborative planning just – in –time	(e.g. BIM) Pull scheduling approach reduce inventory
Continuous improvement	Huddle meetings first-run studies current state mapping future state mapping	Start of the day meeting plan do check act
Transparency	Five S's visual Management	Visualize production methods visualize production process

Source: (Eriksson, 2010; Sacks, et al. 2010; Refaat H. Abdel-Razek, 2007; Salem et al. 2006)

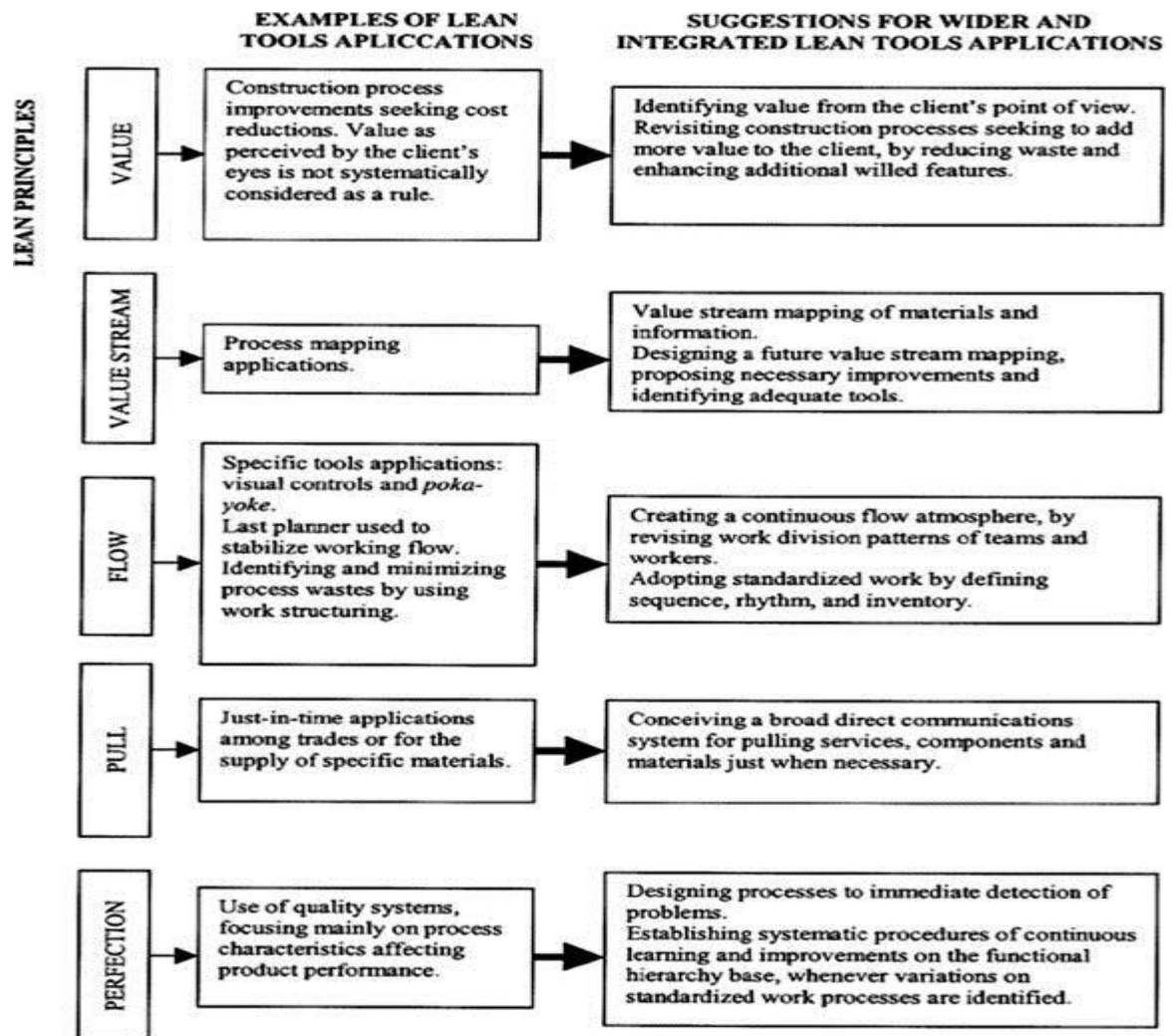


Figure 2.3 - Examples of lean tools in construction implementation and suggestions (Picchi & Granja, 2004).

2.14 BARRIERS TO IMPLEMENTING LEAN CONSTRUCTION CONCEPT

Many researchers have recognized some issues as well as challenges to implementation of Lean Construction. For example, Vinodh & Balaji (2011) and Atkinson (2010) stated that, the utmost imperative factor in the implementation of Lean Construction is ‘*culture*’, which may have a positive or negative influence throughout the journey of lean; they consider that there is a misunderstanding of lean principles, plus unawareness about the cultural requirements of the Lean Construction Concept (LCC).

Liker (2004) viewed ‘*subculture*’ as a possible foundation of difficulties whereas,

Womack and Jones (2005) emphasized ‘*resistance*’ to taking in fresh concepts in this respect. According to Bhasin (2012) numerous factors that could obstruct LCC,

counting: *'management time'* *'senior management'* and *'workforce skills'* *'cost of investment'*; *'supervisory'*; *'attitudes of employee /resistance to change'*; *'cultural issues'* *'external and internal funding'*; *'shareholders and owners'*; as well as *'absence of implementation knowledge'*.

Furthermore, Deloitte and Touché (2002) proposed that the core barriers to LCC are *'investment and cost'* *'company culture'*, *'staff attitudes'*, *'change issues'*, as well as *'mix-up of the process and its advantages'*. Likewise, the Lean Enterprise Institute 2005, cited in Bhasin (2012) advocated that drawbacks consist of *'management resistance'* *'absence of implementation knowledge'*, *'backsliding into old ways of working'*, *'failure to identify the financial value of lean practices'*, *'employee resistance'* as well as *'nonexistence of crisis to create a sense of urgency'*.

According to Boyer and Sovilla (2003) the core barriers for Lean practice are; *'misunderstanding and underestimating the managerial'* as well as *'cultural influence of it'*, and *'unaware requirements for creating a lean culture'*; *'inconsistent procedures and impression concerning the progress'*; *'difficulty in maintaining lean principles'*; and *'employing LCC as a set of tools rather than viewpoint for doing business'*.

As suggested by Atkinson (2010) there has been a delusion of LCC which may have an adverse influence on the implementation of LCC; various organizations see LCC as a set of tools in a firm system, instead of as a viewpoint that is directed to assist business needs. Moreover, Atkinson (2010) emphasized that organizations see LCC only as a *'cost-reduction system'*, as well as *'misread the main requirements'*, and *'the advantages of LCC'*.

2.15 ENABLERS OF LEAN CONSTRUCTION

Prior to the application and implementation of the lean techniques, it behooves proper documentation of the advantages of lean, which is one of the imperative areas to be well

thought-out as an Organization. Drivers as referred to in this perspective of study is the critical success factors required by Organizations to adopt lean. Lean techniques implementation have been accredited with varied factors that drives its activities. These drivers are continuous and efficiency improvement, waste elimination, cost savings and operational efficiency. Furthermore, business pressure, increasing competitive advantage, customer requirements, government policy and regulation are also drivers of lean. The origination of these drivers can be of external or internal nature depending on the Organization. Request for improved efficiency as well as the need for growth of service with inadequate availability of resources are the drivers needed for the introduction of process improvement methodologies such as lean (Radnor & Walley, 2008).

Crute *et al.* (2003) in a case study undertook a survey in the aerospace business identified and stated five important factors for the implementation of lean techniques. These factors are listed as follows: change strategy target and holistic, company culture, product focus, senior management commitment as well as timing for performance advancement (Crute *et al.* 2003).

As cited in Ogunbiyi (2014), the critical success factors are as follows: (1) Top management support; (2) Business plan and vision ; (3) Project; (4) Effective communication, education as well as training; (5) Change management and organizational culture knowledge management, knowledge transfer; (6) Organizational structure; including (7) performance measurements, Monitoring and evaluation of performance (Banuelas & Anthony, 2002).

Management's commitment and support is required for a successful implementation of lean as it is a strategic driver. This will help to sustain the lean focus.

2.16 ASSESSING LEAN TECHNIQUES IN CONSTRUCTION

The Rapid Lean Construction Quality Rating Model according to Vieira *et al.* (2012) evaluates the implementation of Lean Building principles of two building companies in the State of Goias. By applying and understanding, the lean principles and thinking in these companies their performance levels were obtained. After evaluation, recommendations were made to help the companies put into use the lean practices in a more effective means (Vieira *et al.* 2012).

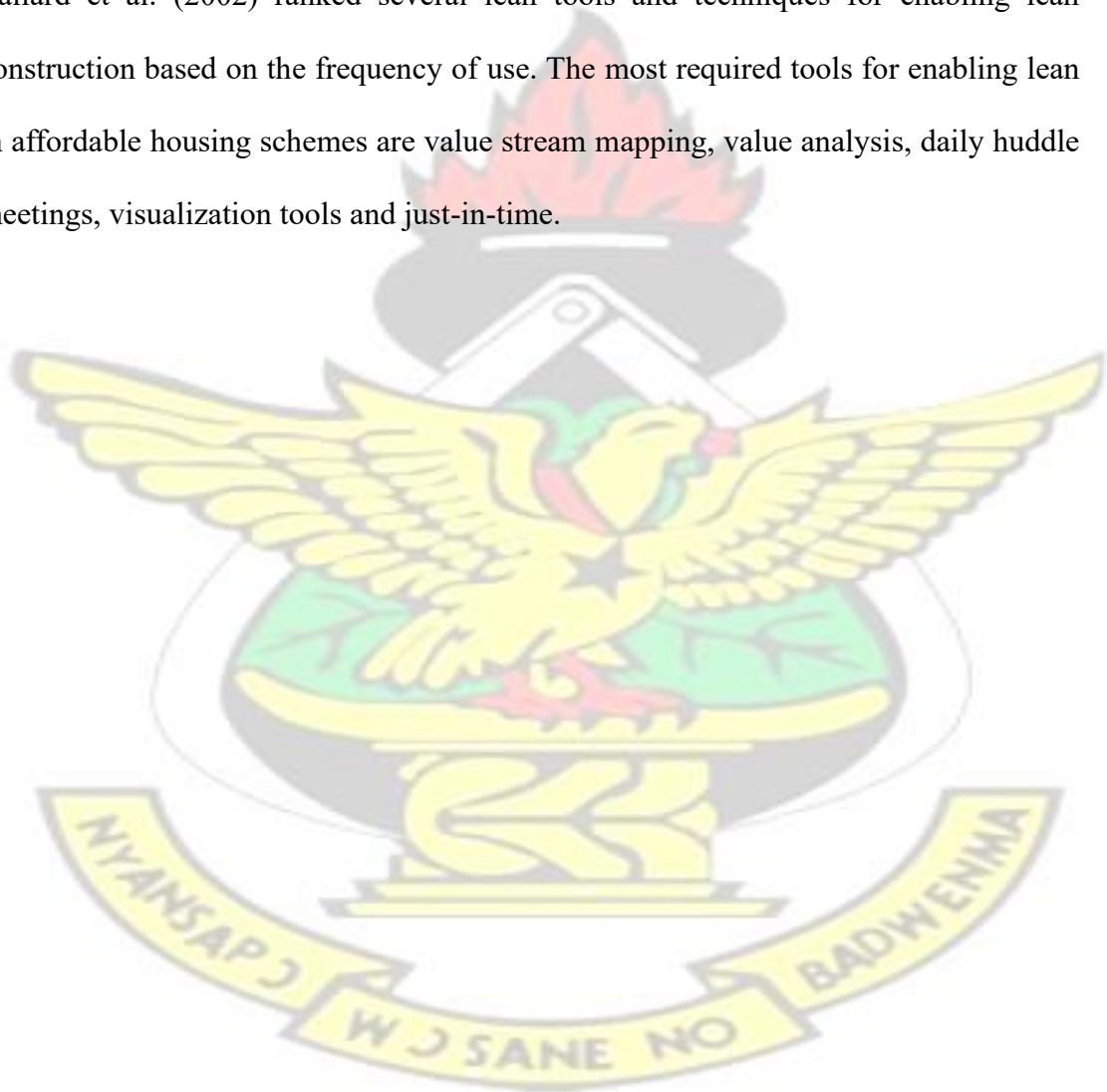
To ascertain that the anticipated advantages achieved by implementing lean practices in building projects, concerned stakeholders must be provided with evidence to motivate them to regularly apply the lean construction (Vieira *et al.* 2012). Salem *et al.* (2005) conducted a field study to evaluate the efficiency of some lean construction practices including last planner, first run studies, improved visualization, everyday huddle meetings, the 5s process, and fail safe for quality. It was found out that these practices attained more effective results than anticipated. However, the outcomes of application did not meet expectations of the tools and techniques employed in the study by the team (Salem *et al.* 2005).

2.17 LINKAGES BETWEEN LEAN AND AFFORDABLE HOUSING CONCEPT

The affordable housing scheme in Ghana has been plagued with the following challenges; high materials wastage, double handling of materials, poor coordination and a customer- push driven approach. These are characterized by the direct labour approach to project delivery, the stock piling of materials leading to double handling, low levels of coordination between suppliers and contractors. Lean construction is a system of maximizing value and reducing or eliminating waste in a building project.

Several areas have been identified as linkages between lean and affordable housing concept. These areas included resource management, waste reduction, value maximization, design optimization, quality improvement, health and safety improvement, performance maximization, resource management, energy minimization, elimination of unnecessary process, and cost reduction (Aziz & Hafez, 2013). Lean and affordable housing share the same goal of waste minimization, value maximization and cost reduction but with different approaches.

Ballard et al. (2002) ranked several lean tools and techniques for enabling lean construction based on the frequency of use. The most required tools for enabling lean in affordable housing schemes are value stream mapping, value analysis, daily huddle meetings, visualization tools and just-in-time.



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Previously, the chapters presented the general introduction of the study, as well as the literature review on the phenomenon under study. These helped to respectively introduce the study, and put the study into perspective. This chapter goes further to present the methodology adopted for the research work to complete the various objectives. This includes the research instrument design, study population, data collection, research design, sample size determination, data analysis and ethical considerations.

3.2 RESEARCH STRATEGY

This refers to either how the research objectives are interrogated, quantitatively or qualitatively (Saunders *et al.* 2007; Naoum, 1998). Qualitative and quantitative represent the two main research strategies (Naoum, 1998). Qualitative research strategy is used in eliciting thoughtful and insights about the world founded on individual perception (Fellows and Liu, 2008). Certainly, Naoum (1998) reveals that qualitative approach to research is 'subjective' in nature and stresses on experiences, meanings, descriptions etc. Moreover, information gotten using qualitative approach encompasses complete descriptions of people, situations, events, or observed behaviour, making it productive when knowledge about the topic is limited (Polit & Hungler, 2001; Naoum, 1998).

Appropriate to the quantitative research method, effort is made to collect accurate data, study relations among facts and ascertain how such facts including relationships match with theories as well as the previous conducted research findings (Fellows and Liu,

2008). Again, it is worth of noting that data gotten by quantitative method is numerical, making it "objective" in reality (Polit & Hungler, 2001).

When both qualitative and quantitative approaches are employed in a research, it is referred to as the mixed method (Creswell & Clark, 2007). These two methods, that is, qualitative and quantitative methods, have their advantages and disadvantages, and for that matter, are sometimes used together for complementary purposes (Fellows & Liu, 2008). Thus, giving the opportunity for each of these methods to benefit from each other thereby avoiding the weakness in each approach (Mingers & Gill, 1997). With regards to this research, quantitative approach was used to achieve the three research objectives; *“to assess the stakeholder’s perception on the concept of Affordable Housing; to identify the potential barriers to the application of LCC to Affordable Housing Schemes in Ghana; and to identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana.”* Literature was thoroughly reviewed for understanding of the concept of lean construction and to identify potential lean drivers in executing Affordable Housing Schemes in Ghana. Secondly, the various variables that were obtained from literature were then used to prepare the questionnaire for the survey.

3.3 RESEARCH DESIGN

To achieve the research objective, a review of existing literature concerning Affordable Housing Schemes, and Lean Construction Principles and applications were conducted. Both closed-ended and open-ended questionnaire was made available to respondents to elicit for information.

For the first stage of data collection, relevant literature on the definition of Affordable Housing, the available lean practices in Construction, by various authors were reviewed. The literature gathered on the Affordable Housing schemes in Ghana and the gap in implementing the ‘lean construction’ philosophy was studied to ascertain the main

problems that were employed in formulating the interview schedule and the questionnaire (Saunders *et al.* 2007). Though, in formulating the review, information that supports empirical study results was considered in that, the evidence quality made available by unreliable data is weaker than that made available by empirical study (Aveyard, 2007).

Finally, information was gathered from Construction professionals who work with public and private organizations and consultancy firms in the Greater Accra Region of Ghana through a closed ended questionnaire. Critical consideration was taken to ensure that the questionnaire reports the research objectives when preparing the questionnaire.

3.4 STUDY POPULATION

Population of a study constitutes all individuals (respondents), items or organization whose contribution is primarily providing relevant and objective information to a given research work. The study targeted construction professionals in Ghana. These professionals include Project Managers, Procurement Managers, Engineers, Architects, Quantity Surveyors and Contractors who work in public sector organizations, and consultancy firms involved in the Affordable Housing Project in Ghana. These professionals were selected because they are involved in the implementation and delivery of the Affordable Housing Scheme in Ghana directly. Though, these respondents work in different organizations of interest, thus it made it tough to get the size of the population from which a probability sample size could be used. Hereafter, the sample size was obtained by means of purposive sampling (**see Section 3.5**).

A total of 60 questionnaires were distributed to mainly consultants (Architects, Quantity surveyors, Procurement Managers, Engineers and Project Managers). The attention on the consultants in the questionnaire administration was due to the major role consultants play in pre-contract doings.

3.5 SAMPLE AND SAMPLING TECHNIQUES

After the population of the research has been defined and selected, the researcher has to decide based on the logical constraints (size of the population, time, money, etc.), if all elements of respondents of the study can be reached. It is very important to determine the sample size of a given population of any scientific research (Saunders *et al.* 2007). This sample size requires representing the population in order to make the findings of the survey generalizable, within random error limits (Bartlett *et al.* 2001). However, it is important to select a sample size that would represent adequate of its population (Field, 2005; Bartlett *et al.* 2001).

Non-probability sample was used to draw the sample population as it “derives from the researchers targeting a particular group, in the full knowledge” that it might not “represent the wider population” (Cohen *et al.* 2000).

The purposive sampling approach was used in selecting the study population, which consisted of, experts (most of who are consultants) involved or have knowledge in the study. The researcher has sufficient facts of the subject to choose sample of professionals including foci selected in this sampling method in relation to the type of the subject in purposive sampling. Consequently, the researcher’s capabilities as well as skills to get suitable people to contribute to the success of the objectives of the study play imperative part on the result of research employing this sampling technique.

3.5.1 Survey Return

A total number of 60 copies sent out by the researcher of which 45 copies were posted through email and 15 copies were hand-delivered to the respondents in the built environment. Table 3.1 below displays the outcome of the questionnaire distributed and their corresponding response percentage. Out of thirty (30) questionnaires received from respondents, two were found to be incomplete and not suitable for the analysis.

Hence, the sample size used for the questionnaire survey was twenty-eight (28).

Table 3. 1 - Survey Return

Questionnaires Delivered	Quantity (No.)	Percentage (%)
Rejected questionnaires	2	3%
Responded questionnaires	28	47%
Unreplied questionnaires	30	50%
Total	60	100%

Source: Field Survey Data, 2016

3.6 TYPES OF SOURCES OF DATA

Data was gathered from primary sources. This refers to the kind of data gathered from original sources by the researcher. The primary data was gathered through the administering of questionnaires to respondents. The questionnaires were administered to collect data related to the topic and objectives of the study. Personally, the questions were administered together with any explanations on the study topic or challenge in understanding the questions were presented on site.

Moreover, secondary literature consisted of all the information required to furnish the project topic. The secondary literature used all the relevant information of reference books, published research reports and academic journals. This information was used to get a preliminary understanding into the study, make available a background to the study, classify and categorize all the key issues that could be addressed by the primary research.

The primary data used secondary literature review to describe the topic and all the factors in the form of dependent variables that needed to be studied by quantitative methods. Both data gathering methods i.e. primary together with secondary, presented advantages as well as disadvantages for the researcher. Secondary literature was easily available and accessible, but was always associated with biasness, where as the primary

data was more expensive and time consuming. Still, both methods were used to back the information and guidelines needed for the research.

KNUST



3.7 METHOD OF DATA COLLECTION

Table 3. 2 - Method of Data Collection

RESEARCH QUESTION	RESEARCH OBJECTIVES	DATA REQUIRED	SOURCES OF DATA	MODE OF COLLECTION
What are the perception of stakeholders on the Affordable Housing Concept in Ghana	To determine the perception of stakeholders on the concept of Affordable Housing.	❖ Respondent's perception of affordable housing. ❖ Respondent's definition. ❖ Factors influencing the concept of affordable housing.	➤ Primary data ➤ Secondary literature	• Questionnaires • Reference books, published research reports and academic journals
What are the potential barriers to the application of LCC to the Affordable Housing Scheme in Ghana?	To identify the potential barriers to the application of LCC to Affordable Housing Schemes in Ghana	❖ Respondent's awareness of lean construction ❖ Respondents assessment of barriers to LCC in affordable housing schemes in Ghana.	➤ Primary data ➤ Secondary literature	• Questionnaire • Reference books, published research reports and academic journals
What are the enablers or drivers to the implementation of Lean Construction Concept to the execution of Affordable Housing Schemes in Ghana?	To identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana.	❖ Management, ❖ Construction & ❖ Design stages. ❖ Environmental benefit. ❖ Economic benefit. ❖ Social benefit.	➤ Primary data ➤ Secondary literature	• Questionnaires • Reference books, published research reports and academic journals

Source: Author's construct, 2016

3.8 DATA ANALYSIS

The presentation of data analysis is highlighted in this section. This has been respectively presented under subsection 3.8.1.

3.8.1 Quantitative Data Analysis

Questionnaire survey was the instrument used in obtaining the data and analyzed using quantitative techniques as presented hereafter. Apart from the open ended and closed ended questions in Section A and B, the Likert Scale was used as a measure of significance of the various variables presented under Sections C and D. For example, under Section C, respondents were asked to rank on a scale of 1-5, the degree of significance of the various barriers to the application of LCC to the Affordable Housing Schemes in Ghana. The figure '1' represents "Highly Insignificant", while '5' represents "Highly Significant". Again, '3' represents "Undecided". However, when a respondent chooses '3', it is deemed to be "neutral" (Ayarkwa et al. 2010). The Statistical Package for the Social Sciences (SPSS v20.0) was used for the processing and analysis of the data acquired.

Factor analysis was the analytical tool of SPSS used in analyzing the data. Likert and semantic differential variables are mostly used with Factor Analytical tool of SPSS as an exploratory device.

Factor Analysis when applied in an exploratory study is used to summarize variables into main representative components or factors. Nevertheless, the test of data adequacy, to determine whether factor analysis statistical technique is appropriate, is key to a study (Coakes et al. 2010).

The essential principle behind factor analysis is that, a number of components contribute to the score on any scale of a variable or item. This represents the influence of fundamental factors to the variable. The weighted scores of an individual item is measured by its relative importance with respect to various factors in the constructs are combined together with an error component to form its item score (Moser & Kalton, 1971).

Factor analysis comprises of three types of factors namely: general factor, group factor, and specific factor. The Exploratory Factor Analysis (EFA) affords the researcher the opportunity to explore the prime dimensions of groups of variables to generate a theory, or a model; it is generated from a relatively large group of latent constructs, which are represented by a group of variables. This class of factor analysis is exploratory in nature; the researcher has no expectations of the number or nature of the variables (Henson & Roberts, 2006; Thompson, 2004). On the other hand, CFA is used to study the connections between groups of continuous latent variables and a group of observed variables. CFA varies from EPA by allowing the researcher to impose a model or structure on the data and test how reliably the model "fits". The 'model' is a hypothesis regarding; (a) the number of factors, (b) whether the factors are uncorrelated or correlated and (c) how items are related with the factor. Models with differing configurations are compared using structural equation modelling (Santor *et al.* 2011). Exploratory factor analysis was employed for the purpose of this research.

3.9 ETHICAL CONSIDERATIONS OF THE STUDY

It is a requirement for ethical considerations to be made in every scientific research (EC, 2010). These are relating to issues regarding how a given research is carried out, that is, from the conception and clarification through to the writing up of the research topic and research findings in a moral and liable way (Saunders et al. 2007).

According to Singer (2008), protecting confidentiality and securing informed consent of the respondents of the survey are most essential to the issues pertaining to research ethics. Therefore, the following with regards to ethical considerations were ensured: First of all, before the administration of the questionnaires (refer to Appendix 1), the researcher introduced himself and the purpose of the study to the respondents in order to avoid impersonation. Secondly, participation in the study, thus the questionnaire survey, was not made compulsory but rather based on the willingness of respondents.

In addition, the use of offensive, discriminatory, or other unacceptable language was avoided in the formulation of the Questionnaire survey. Thirdly, anonymity and privacy of respondents was given the maximum consideration. During the fieldwork, all forms of identification including names, addresses, and telephone numbers of respondents were avoided.

KNUST



CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

The research methodology outlined the use of questionnaire survey in conducting this research (Appendix). In fulfilling the objectives of this research work the questionnaire survey was designed to address the research aim; “Enablers of Lean Construction Concept to Affordable Housing Schemes in Ghana”.

After finalization of the entire research questionnaire, photocopies of it were administered to potential respondents by hand delivery and others were mailed electronically. The email address of prospective respondents were obtained from the internet for questionnaires by email method whereas the questionnaire by delivery method; all respondents ('built-professionals' in the affordable housing scheme in Ghana) that the researcher could contact were hand delivered.

4.2 DEMOGRAPHY OF RESPONDENTS

The output of the demography of the respondents were arrived after analysis. Out of the respondent's profile which outlined professional positions: Architect, Engineer (Building/Civil), Project Manager, Quantity Surveyor, Procurement Manager, and other accommodated professions (Geomatic Engineer and Environmental Planner), 7% were Architects, 7% were Engineers (Building/Civil), and 7% were other (accommodated) professions. The high rating professions in a descending order were Quantity Surveying, Project Management and Procurement Management, rating 32%, 29% and 18% respectively (refer Table 4.1).

Respondents highest educational qualification attained were also retrieved from the output. The results show 57% of the respondents are Master's level certificate holders, followed by Bachelor qualification which accounted for 29% and lastly, both Post Graduate Diploma

(PG. Dip.) and HND or lower qualification accounted for 14% respectively. The industrial experience of the respondents ranges between 0 to 15 years.

Out of the 29 respondents, 33% of them have working experience up to 5 years and 25% have working experience above 15 years. These account for 58% of the total number of respondents. Those of working experience between 5-10 years and 10-15 years are 21% respectively.

Besides the working experience of the respondents, 64% are members of a professional body whereas 36% of respondents did not belong to any professional body. With respect to the above percentage loadings, it can be concluded that the sample reflect a good professional base making it reasonable to conclude that the knowledge base of the respondents relating to construction management can be trusted to a great degree.

Essentially the respondents' stage (s) of construction involvement such as 'Pre-Contract stage', 'Post-Contract stage' and 'Construction stage' are 18% of the respondents were involved in pre-contract, 28% were involved in construction, 41% were involved in both pre-contract and construction and 56% were involved in all three (3) categories listed.

Table 4. 1 - Demography of Respondents

Question	Demography	Frequency	Percentage (%)
1. What is your professional background?	a. Architect	2	7.1%
	b. Engineer (Building/Civil)	2	7.1%
	c. Project Manager	8	28.6%
	d. Quantity Surveyor	9	32.1%
	e. Procurement Manager/Officer	5	17.9%
	Others (Specify)	2	7.1%
	TOTAL:	28	100.0%
	a. MBA/MSc/MPhil/PhD	16	57.1%

2. What is your highest educational attainment?	b. PG. Dip.	2	7.1%
	c. Bachelor Degree(s)	8	28.6%
	d. Higher National Diploma (HND)	2	7.1%
	TOTAL:	28	100.0%
3. What are your year(s) of experience in your area of work?	a. Between 0 – 5 years	9	32.1%
	b. Between 5 – 10 years	6	21.4%
	c. Between 10 – 15 years	6	21.4%
	Above 15 years	7	25.0%
	TOTAL:	28	100.0%
4. Are you a member of a professional body/bodies?	a. Yes	18	64.3%
	b. No	10	35.7%
	TOTAL:	28	100.0%
5. Which stage of Construction have you been involved in essentially?	a. Pre-Contract stage	5	17.9%
	b. Post-Contract stage	0	0.0%
	c. Construction stage	4	14.3%
	d. Pre-Contract & Construction stage	3	10.7%
	e. All stages	16	57.1%
	TOTAL:	28	100.0%

Source: Field Survey Data, 2016

4.4 PART B: CONCEPTS AND MEANING OF AFFORDABLE HOUSING

Question 1: - In your own view or opinion, how do you understand the concept of Affordable Housing?

Comments given - participants that commented to this question predominantly commented around these four generalized definitions gathered: “affordable housing is low cost housing for medium income household”, “housing provided by government for people in the lower and middle income brackets”, “the provision of houses that the average income earner can afford within a reasonable period of time” and “housing constructed at a subsidized rate”.

Discussion of results - Regarding the opinion of respondents to their

understanding of the concept of the Affordable Housing Scheme, it was arrived that all respondents who answered this question had some level of understanding of the Affordable Housing Scheme in Ghana and the category of people the scheme addresses. Respondents generally stated that affordable housing is the sole responsibility of the governing administration of the country.

Question 2 - What are some of the factors that influence the concept of Affordable Housing Schemes?

Comments - Two (2) respondents agreed that Social and Demography are the only influencing factors respectively; eight (8) respondents agreed that Government policies are the only influencing factors; two (2) respondents agreed respectively to Social & Demography and Demography & Government policies; whereas seven (7) respondents agreed to all three factors. Refer Table 4.2 below.

Table 4. 2 - Factors Influencing the Concept of Affordable Housing

		Frequency	Percent (%)
Valid	Social issues	2	7.1
	Demography	2	7.1
	Government policies	8	28.6
	All	5	17.9
	Social & Demography	2	7.1
	Demography & Government policies	2	7.1
	Government Policies & Social issues	7	25.0
	Total	28	100.0

Source: Field Survey Data, 2016

Discussion of results:

From table 4.2; it can be noted that about 29% of respondents believe that affordable housing could be greatly influenced by Government policy. Government Policies & Social issues is ranked second with 25% of respondents, 17.9% of respondents are of

the view that all three outlined factors influence the affordable housing concept, whereas demography, social issues, demography & government policies were weighting 7.1% respectively. This indicates that Government policies and Social issues as cited in mainly influence affordable housing (Nsiah-Gyabaah, 2013; UN-HABITAT, 2011; Boamah, 2010).

Question 3 - Please tick ☐ or click in the box ☐ which one of the following in your opinion best defines Affordable Housing?

Type of question - opinion based/ closed end question/ multiple answers. **Responses** -

Table 4.3 essentially depicts the frequency and

percentages of respondents in answering the question.

Table 4. 3 - Affordable Housing Defined

		Frequency	Percent (%)
Valid	provision of 'adequate shelter' on a sustained basis	2	7.1
	housing provided to those whose needs are not met by the open market	1	3.6
	housing that medium income residents may afford according to their country and region	2	7.1
	housing that assists lower income households in obtaining and paying for housing without experiencing undue financial hardships	22	78.6
	the housing in which low or middle income households would be able to afford with no more than 30% of their income	1	3.6
	Total	28	100.0

Source: Field Survey Data, 2016

Discussion of results:

As indicated in Table 4.3, 22 out of the 28 respondents agreed to the definition in option 4: “housing that assists lower income households in obtaining and paying for appropriate housing without experiencing undue financial hardship” (Milligan *et al.* 2004). The researcher agrees with the respondents on this definition of the Affordable Housing Concept since it addresses the target group of people “lower income households” a payment plan or terms of payment “in obtaining and paying” the condition of the facility “appropriate housing” and states a sustainable critical factor “without experiencing undue financial hardship”. According to the researcher, this definition is by far the most appropriate definition of the Affordable Housing concept.

Question 4 - Do you know of any Housing Scheme in Ghana?

A. Yes ☐ No ☐

Type of question - opinion bases/ close end question/ dichotomous yes/no question

Responses - 26 out of 28 respondents representing a 93% response rate indicated that they are aware of the government of Ghana’s Affordable Housing Scheme (Refer Table 4.4). Table 4.4 essentially depicts the frequencies and percentages of respondents in answering the question.

Discussion of results - respondents were generally aware of affordable housing schemes in the country. Further discussions with a number of the respondents revealed that they were not confident in the scheme since they were of the opinion that there has not been any clarification as to who qualifies and which income group of people the scheme addresses.

Table 4. 4 - Respondents’ Awareness of Affordable Housing Schemes

	Frequency	Percentage (%)

Yes	26	92.86%
No	2	7.14%
Total	28	100.0%

Source: Field Survey Data, 2016

4.5 PART C: BARRIERS TO APPLICATION OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES

Factor analysis tool of IBM SPSS Version 20 was used to analyze the Part C of the questionnaire. It is to determine the relationship between the factors and the validity of the enlisted factors in the questionnaire. Respondents were asked to identify and rank the degree of significance to the possible barriers to the application of lean construction concept to affordable housing schemes. The answers to this question were assessed by using a Likert scale ranking from highly insignificant to highly significant. The questions were divided into three sub categories or phases that were; 'Management Related', 'Construction Stage Related' and 'Design Stage Related barriers.

From the analysis of the descriptive frequencies, it was derived that 50% of respondents ranked the listed barriers as highly significant while 39% ranked as significant. On the other hand, about 11% of the respondents alternant between undecided and insignificant.

In order to efficiently use the tool of factor analysis in SPSS, satisfaction of assumptions were carried out. The adequacy of the variables were met by using the Measuring Sample Adequacy assumption. The determinant of the correlation between variables were greater than 0.0001 (which is 2.028). On the other hand the test assumption using Kaiser-Meyer-Olkin (KMO) and Bartlette's Test of Sphericity were used to measure further the adequacy of the sample. The KMO value is 0.611 which is within the acceptable limit even though it is termed a mediocre value (that is between 0.60 to 0.69) and the Bartlette's values is significant at a value of less than 0.50; our value is 0.0001 which is approximately 0.000 as shown in Table 4.5. The test of sample

adequacy was successfully met to proceed to the analysis of the factors for their relationship and validity.

Table 4. 5 - Test for Sampling Adequacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.611
Bartlett's Test of Sphericity	Approx. Chi-Square	251.242
	df	105
	Sig.	.000

Source: Field Survey Data, 2016

4.5.1 Communalities

From Table 4.6 below, the communalities loading demonstrate that the relationship of the various under listed factors are very high. The factors have a high level of relationship with each other. This reveals that, all the factors are important to one another. Factor (variable) 1 in the communalities, “Lack of customer and production focus” loads 0.618. This means its relationship with other variables (or barriers) is almost 62%. It also affirms that with respect to other variables it cannot be ignored.

Table 4. 6 - Loadings on Communalities of Barriers

	Initial	Extraction
Lack of customer and production focus	1.000	0.618
Lack of adequate lean awareness/understanding	1.000	0.880
Lack of Training	1.000	0.891
Fragmentation of Profession	1.000	0.683
Absence of long term planning	1.000	0.607
Ineffective management practices	1.000	0.777
Quality assessment focus on conformance	1.000	0.761
Fragmentation of supply chain	1.000	0.558
'Wait and See' attitude	1.000	0.739
Ineffective factory production	1.000	0.775
Ineffective management practices	1.000	0.746
Non-application of Just-In-Time (JIT) delivery of materials on site	1.000	0.710
Procurement method	1.000	0.839
Inaccurate design among professionals (Arch., C&S, M&E)	1.000	0.792
'Cut and Paste' from previous project	1.000	0.716

Source: Field Survey Data, 2016

Extraction Method: Principal Component Analysis.

4.5.2 Components Loading

A four factor (or component) Factor Analysis was extracted from the Rotated Component Matrix as displayed in Table 4.7 below. It was arrived at using a factor loading of an Eigenvalue (a measure of explained variance) greater than 1.0 as shown in Table 4.8.

Table 4. 7 - Rotated Component Matrix (Barriers)

	Component			
	1	2	3	4
Lack of training	0.876			
'Cut and Paste' from previous project	0.771			
Fragmentation of profession	0.761			
Lack of customer and production focus	0.702			
Inaccurate design among professionals (Arch., C&S, M&E)	0.678		0.462	
'Wait and See' attitude	0.609		-0.357	0.491
Fragmentation of supply chain	0.535	0.426		
Ineffective management practices		0.877		
Ineffective factory production		0.764		
Ineffective management practices		0.693	0.446	
Procurement method			0.906	
Absence of long term planning			0.692	
Quality assessment focus on conformance				0.858
Non-application of Just-In-Time (JIT) delivery of materials on site	0.511			0.624
Lack of adequate lean awareness/understanding	0.520	0.423		0.593

Source: Field Survey Data, 2016

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization. a.

Rotation converged in 5 iterations.

Table 4. 8 - Factor Loadings of Eigenvalues

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.208	41.386	41.386	6.208	41.386	41.386	4.236	28.242	28.242
2	1.927	12.846	54.232	1.927	12.846	54.232	2.407	16.049	44.291
3	1.867	12.448	66.680	1.867	12.448	66.680	2.363	15.755	60.046
4	1.090	7.269	73.949	1.090	7.269	73.949	2.085	13.903	73.949
5	0.915	6.100	80.049						
6	0.658	4.386	84.435						
7	0.581	3.871	88.306						
8	0.480	3.200	91.506						
9	0.326	2.174	93.680						
10	0.317	2.115	95.795						
11	0.271	1.808	97.603						
12	0.196	1.309	98.912						
13	0.089	0.591	99.503						
14	0.057	0.377	99.880						
15	0.018	0.120	100.000						

Source: Field Survey Data, 2016

KNUST

60



4.5.3 Discussion of results

Principal component factor analysis with varimax rotation was conducted to assess the underlying structure for the 15 items of *BARRIERS TO APPLICATION OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES IN GHANA* Questionnaire. (The assumption of independent sampling was met. The assumption of normality, linear relationships between pairs of variables, and the variables' being correlated at a moderate level were checked). Four factors were derived, based on the fact that the items were designed to index four constructs: management related, construction related and design related. After rotation, the first factor accounted for 28.2% of variance, the second factor accounted for 16.0%, the third factor accounted for 15.8%, and the forth factor accounted for 13.9% as displayed in table 4.8 above. Table 4.9 displays the items and factor loadings for the rotated factors, with loadings less than 0.35 omitted to improve clarity. The results of the factor (or component) loadings and the final composition for each item is displayed in the Tables 4.9 and Table 4.10 below. The first and second factors, which seem to index management related barriers has high loadings for the first 10 items. This means that these factors are directly related to each other even though it has a level of relation with the rest of the factors listed. The third factor, which seemed to index design related barriers had high loading on the next two items in Table 4.9. The forth factor, which seemed to index construction related, loaded highly on the last four. The factors were named, analyzed and the items were grouped as displayed in Table 4.9. The concluding table is displayed in Table 4.10.

Table 4. 9 - Definition of Factor or Component

CODE	COMPONENT 1 -	
	MANAGEMENT RELATED	
BALCC3 BALCC15	Lack of training	0.876
BALCC4	'Cut and Paste' from previous project	0.771
BALCC1	Fragmentation of profession	0.761
	Lack of customer and production focus	0.702
BALCC14 BALCC9	Inaccurate design among professionals (Arch., C&S, M&E)	0.678
BALCC8	'Wait and See' attitude	0.609
	Fragmentation of supply chain	0.535

Source: Field Survey Data, 2016

CODE	COMPONENT 2 -	
	MANAGEMENT RELATED	
BALCC11 BALCC10	Ineffective management practices	0.877
BALCC6	Ineffective factory production	0.764
	Ineffective management practices	0.693

Source: Field Survey Data, 2016

CODE	COMPONENT 3 -	
	DESIGN RELATED	
BALCC13 BALCC5	Procurement method	0.906
	Absence of long term planning	0.692

Source: Field Survey Data, 2016

CODE	COMPONENT 4 -	
	CONSTRUCTION RELATED	
BALCC7 BALCC12	Quality assessment focus on conformance	0.858
	Non-application of Just-In-Time (JIT) delivery of materials on site	0.624
BALCC2	Lack of adequate lean awareness/understanding	0.593

Source: Field Survey Data, 2016

Table 4. 10 - Defined Groups of Potential Barriers

MANAGEMENT RELATED	CONSTRUCTION RELATED	DESIGN RELATED
Lack of training	Quality assessment focus on conformance	Procurement method
'Cut and Paste' from previous project	Non-application of Just-In-Time (JIT) delivery of materials on site	Absence of long term planning
Fragmentation of profession	Lack of adequate lean awareness/ understanding	

Source: Field Survey Data, 2016

4.5.3.1 Management related barriers

Based on the analysis derived in table 4.9, respondents ranked ten enlisted factors above 53% under the heading 'Management related barriers' as potential barriers to lean implementation.

Likewise, many studies have identified several management related factors and these include; poor coordination, poor understanding of customer needs, poor planning, lack of delegation to enhance work flow, logistics problems, lack of a participative management style for the workforce and absence of look-ahead planning (Alinaitwe, 2009). Top management support is critical to the implementation of LCC to affordable housing schemes in Ghana. In achieving successful implementation of both concepts, the management of every organisation has a fundamental role to play.

4.5.3.2 Construction related barriers

The enlisted factors under this category are; quality assessment focus on conformance, non-application of Just-In-Time (JIT) delivery of materials on site and lack of adequate lean awareness or understanding.

According to Forbes *et al.* (2002), measurement of performance have mainly been regarded in terms of time, quality, cost and adding health and safety within the construction industry without paying attention to customer satisfaction. Regarding continuous improvement, the 'three triangles'; time, cost and quality, for measuring project performance are not adequate.

Alarcon & Serpell (1996) stated that the three triangles are neither adequate or efficient to addressing the root causes of quality and productivity losses in the industry. This is evident in the affordable housing schemes in Ghana.

The most challenging, yet more commercially worthwhile, aspects of implementing lean is the improvement of a lean supply chain in construction. The affordable housing scheme practices the system of bulk buying and stockpiling of materials. This results in double handling of materials from the stores to the construction site. Schenck (1998) opined barriers to SCM arises in industry because of the lack of technical expertise and current technological trends across the supply chain. The supply chain management needs improvement efforts from managers in organisations.

4.5.3.3 Design related barriers

From Table 4.9; 91% and 70% of respondents ranked Procurement method and absence of long term planning respectively as potential design related barriers to lean application in affordable housing schemes in Ghana. The method of procurement could affect the impact of lean on a construction project. The method of procurement is key to the implementation of a lean concept in construction. This if not handled well could

be a potential barrier. There exist new methods of procurement which are noted for best practices in construction (Woodward, 2001), whereas substantial waste has been characterized by traditional procurement methods (Johansen & Walter, 2007). This suggests that the procurement method should be the key starting point for customization of lean principles for application to affordable housing schemes in Ghana.

The lack of long-term planning has been identified as one of the obstacles to sustainable building without loss. The benefits resulting from the application of lean are usually done in the long term.

4.6 PART D: ENABLERS OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES IN GHANA.

Part D (Section 1) of the questionnaire survey identified and marked the degree of significance of the possible enablers of lean construction concept to affordable housing schemes in Ghana. The answers to this question were assessed by using a Likert scale ranking from highly insignificant to highly significant.

Factor Analysis tool of IBM SPSS Version 20 was used to assess the underlying structure of the items listed on the questionnaire. The test assumptions as explained above were met. The Determinant value was 6.626, the KMO value 0.622 and

Bartlette's Test of Sphericity is approximately 0.000 as shown in Table 4.11 below. The above values met the assumptions for the application of Factor Analysis to a sample. From the analysis of the questions, it was derived that 68% of respondents ranked the listed drivers as highly significant while 26% ranked as significant. On the other hand, about 6% of the respondents alternant between undecided and insignificant.

Table 4. -**11 Measure of Sampling Adequacy**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.622
Bartlett's Test of Sphericity	Approx. ChiSquare	373.506
	df	120
	Sig.	0.000

Source: Field Survey Data, 2016

4.6.1 Communalities

The relationship between one item with respect to other items is as high as 88%;

“Review of performance/progress towards target” and as low as 66%; *“Customer focus and integration”*. The lowest relational percentage is even far above average. This demonstrates that none of the items enlisted can be ignored. The interpretation of one item is in one way or the other influenced by the other items of the construct. The loadings on the communalities are very high giving a very high positive relationship among the items as shown in the Table 4.12

12 Loadings on Communalities of Enablers

	Initial	Extraction
Management commitment and support	1.000	0.816
Customer focus and integration	1.000	0.662
Effective planning	1.000	0.808
System and process change management	1.000	0.866
	1.000	0.847
	1.000	0.875
Business plan and vision	1.000	0.847
Management evaluation and reporting of performance	1.000	0.720

Table 4. -

	1.000	0.687
	1.000	0.807
Benchmarking of suppliers against each other	1.000	0.723
Wide adoption of lean and sustainability concepts	1.000	0.830
Regular training of workforce	1.000	0.719
Understanding of lean benefits on affordable housing concept	1.000	0.671
Good working environment	1.000	0.831
Team work and composition	1.000	0.847

Source: Field Survey Data, 2016

Extraction Method: Principal Component Analysis.

4.6.2 Components Loading

A four factor (or component) Factor Analysis was extracted from the Rotated Component Matrix as displayed in the Table 4.13 below. It was arrived at using a factor loading of an Eigenvalue (a measure of explained variance) greater than 1.0 as shown in Table 4.14.

13 Rotated Component Matrix (Enablers)

	Component			
	1	2	3	4
Business plan and vision	0.897			
System and process change management	0.834			0.376
Benchmarking of suppliers against each other	0.831			
Good working environment	0.784		0.432	

Table 4. -

Effective planning	0.582	0.474	0.476	
Adoption of a continuous improvement culture		0.817		
Integration of teams and end to end supply chain		0.809		
Understanding of lean benefits on affordable housing concept		0.651		0.376
Management evaluation and reporting of performance		0.641	0.516	
Regular training of workforce	0.558	0.578		
Review of performance/ progress towards targets			0.879	
Communication and coordination between parties			0.722	0.436
Team work and composition	0.549		0.687	
Management commitment and support				0.889
Wide adoption of lean and sustainability concepts	0.367	0.548		0.579
Customer focus and integration	0.429	0.383		0.574

Source: Field Survey Data, 2016

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization. a.

Rotation converged in 9 iterations.

14 Factor Loadings of Eigenvalue

Total Variance Explained

Compo nent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Tot al	% of Varia nce	Cumula tive %	Tot al	% of Varia nce	Cumula tive %	Tot al	% of Varia nce	Cumula tive %
1	7.838	48.990	48.990	7.838	48.990	48.990	4.348	27.175	27.175
2	2.076	12.975	61.965	2.076	12.975	61.965	3.385	21.159	48.333

Table 4. -

3	1.5 85	9.907	71.871	1.5 85	9.907	71.871	2.7 79	17.36 9	65.702
4	1.0 56	6.602	78.473	1.0 56	6.602	78.473	2.0 43	12.77 1	78.473
5	0.9 82	6.139	84.612						
6	0.6 42	4.013	88.625						
7	0.4 71	2.941	91.566						
8	0.3 57	2.232	93.798						
9	0.3 27	2.041	95.839						
10	0.2 19	1.367	97.207						
11	0.1 62	1.012	98.219						
12	0.1 10	0.687	98.906						
13	0.0 74	0.462	99.368						
14	0.0 57	0.356	99.724						
15	0.0 30	0.186	99.910						
16	0.0 14	0.090	100.000						

Source: Field Survey Data, 2016

Extraction Method: Principal Component Analysis.

4.6.3 Discussion of results

Principal component factor analysis with varimax rotation was conducted to assess the underlying structure for the 16 items of ENABLERS FOR IMPLEMENTING LEAN CONSTRUCTION CONCEPT IN AFFORDABLE HOUSING SCHEMES IN GHANA Questionnaire. (Assuming independent sampling was fulfilled. The assumption of normality, linear relationships between pairs of variables were tested, and the variables' were correlated to a moderate level). Four factors were derived based on the fact that the items are designed to index four constructs: Leadership and management related, Organizational and cultural related, Resource, skills and expertise related. After rotation, the first factor accounted for 27.2% of the variance, the second factor accounted for 21.2%, the third factor accounted for 17.4% and return factor accounted for 12.8%. as it is shown in the table above 4.14. Table 4.15 displays the items and factor loadings for the rotated factors, with loadings less than 0.35 omitted to improve clarity. The results of the factor (or component) loadings and the final composition for each item is displayed in the Tables 4.15 and Table 4.16 below. The first factor, which seem to index leadership and management related factors has high loadings for the first 5 items. This means that these factors are directly related to each other even though it has a level of relation with the rest of the factors listed. The Second factor, which seemed to index organizational and cultural related factors had high loading on the next 5 items. The third factor, which seemed to index relational factors, loaded highly on the other succeeding three items. The last three items were loaded on the resource, skills and expertise related factor, which is the fourth factor or component. The concluding table is displayed in Table 4.16.

Table 4. 15 - Definition of Factor or Component

CODE	COMPONENT 1 -	
	LEADERSHIP AND MANAGEMENT FACTOR	
ELCC7	Business plan and vision	.897
ELCC4	System and process change management	.834
ELCC11	Benchmarking of suppliers against each other	.831
ELCC15	Good working environment	.784
ELCC3	Effective planning	.582

CODE	COMPONENT 2 -	
	ORGANISATIONAL CULTURAL FACTORS	
ELCC10	Adoption of a continuous improvement culture	.817
ELCC9	Integration of team and end to end supply chain	.809
ELCC14	Understanding of lean benefits on affordable housing concept	.651
ELCC8	Monitoring, evaluation and reporting of performance	.641
ELCC13	Regular training of workforce	.578

CODE	COMPONENT 3 -	
	RELATIONAL FACTORS	
ELCC6	Review of performance/ progress towards targets	.879
ELCC5	Communication and coordination between parties	.722
ELCC12	Team work and composition	.687

CODE	COMPONENT 4 -	
	RESOURCE, SKILLS AND EXPERTISE FACTORS	
ELCC1	Management commitment and support	.889
ELCC12	Wide adoption of lean and sustainability concepts	.579
ELCC2	Customer focus and integration	.574

Source: Field Survey Data, 2016

Table 4. 16 - Defined Groups of Enablers

MANAGEMENT AND LEADERSHIP FACTORS	ORGANISATIONAL CULTURE FACTORS	RESOURCE, SKILLS AND EXPERTISE FACTORS	RELATIONAL FACTORS
Business plan and vision	Adoption of a continuous improvement culture	Management commitment and support	Review of performance/ progress towards targets
System and process change management	Integration of teams and end to end supply chain	Wide adoption of lean and sustainability concepts	Communication and coordination between parties
Benchmarking of suppliers against each other	Understanding of lean benefits on affordable housing concept	Customer focus and integration	Team work and composition
Good working environment	Monitoring, evaluation and reporting of performance		
Effective planning	Regular training of workforce		

Source: Field Survey Data, 2016

4.6.3.1 Management and Leadership Factors

The analysis derived were displayed in Table 4.15. Business plan and vision was identified as an enabler to the successful implementation of lean by 89.7% of respondents; 83.4% identified system and process change management; 83.1% identified benchmarking of suppliers against each other; 78.4% identified good working environment; while 58.2% identified effective planning as success factors for implementing lean in affordable housing schemes in Ghana. The concept of vision generation must be reflected by the organisation. Need exist for business plan and vision for a whole integrated lean approach from the onset, an integrated system and process management embedding lean, evaluating and benchmarking suppliers against each other, the creation of a good working environment to adopt and sustain the lean concept and effective planning.

Management responsibility, particularly the top management is key to the application of the lean concept in organisations. Top management support speeds progress. However, the absence of top-level management of the duty of involvement in the middle of the process of change, lack of participation sometimes and obvious reluctance to ask to run the thoughts of the labor force (Womack and Jones, 1996; Sovilla and Boyer, 2003).

The government and the institutions implementing the affordable housing schemes in Ghana should have a common understanding and language change and improvement in their business plan and vision to enable them implement the lean construction concept.

4.6.3.2 Organisational Culture Factors

The following; ‘adaptation of a continues improvement culture’, ‘Integration of team and end to end supply chain’, ‘Understanding of lean benefits on affordable housing concept’, ‘Monitoring, evaluation and reporting of performance’ and ‘Regular training of workforce’ ranked above 55% of respondents weightings in Table 4.15.

The development of a continuous improvement culture is the main factor in the successful implementation of lean in an organisation. Senge et al. (2002) noted the change in the intuitive organization is the combination of aspirations, behaviors and internal changes in the values of the people moving out of the systems, strategies, practices and processes. Achieving a successful affordable housing program, Lean implementation in Ghana requires continuous improvement and organisational culture change.

4.6.3.3 Resource, Skills & Expertise Factors

Table 4.15 and 4.16 highlighted three (3) key enablers under this heading for a successful implementation of lean in affordable housing schemes in Ghana. These are

‘management commitment and support’, ‘extensive acceptance of lean in construction concepts’ and ‘customer focus and integration’.

Successful lean implementation requires possible resources such as employees, time and finance so as to streamline the lean concept in the organisation. Management support together with the availability of monetary funds is required for a successful lean implementation. Employee training is also paramount to the implementation of lean. Staff training in lean principles is necessary because educated workforce and other factors such as management support and funding availability may reflect how a company is ready for the application of lean. Coffey (2000) stated that the implementation of lean construction is dependent on the capabilities and skills of employees to perform successfully, achieve many of its features and its potential.

4.6.3.4 Relational Factors

On the basis of the analysis and the evaluation of the literature has identified a number of internal and external enablers for lean. These are categorized under relational factors namely; ‘review of performance or progress towards targets’, ‘communication and coordination between parties’ and ‘teamwork and composition’.

Effective communication and coordination between parties in the organisation is essential for successful implementation of lean.

Part D (Section 2)

Table 4. 17 - Outlines the responses to the respondents’ answers of Part D (Section 2) questions 1 – 6.

Question	Response	Frequency	Percentage (%)
1. Are you aware or conversant with Lean Construction Principles prior to answering this questionnaire?	Yes	9	32%
	No	19	68%
	Total	28	100%
	Yes	19	90%

2. If NO, has this questionnaire been educative to you?	No	2	10%
	Total	21	100%
3. Do you think Lean Construction is beneficial for an Affordable Housing Scheme in Ghana?	Yes	27	96%
	No	1	4%
	Total	28	100%
4. Do you think that Lean Construction Techniques could improve productivity in Affordable Housing delivery in Ghana?	Yes	28	100%
	No	0	0%
	Total	28	100%
5. Do you think that Lean Construction Techniques when used at site level could generate cost savings?	Yes	28	100%
	No	0	0%
	Total	28	100%
6. Do you think Lean/JIT material supplies are a suitable solution in Affordable Housing delivery in Ghana?	Yes	24	86%
	No	4	14%
	Total	28	100%

Source: Field Survey Data, 2016

Question	Response	Frequency	Percentage (%)
7. Which statement is in your opinion is closer to the truth: Applying techniques from manufacturing to construction is?	a. Possible (with adjustments)	26	93%
	b. Is like fitting a round pole in a square hole	1	4%
	c. None of the above mentioned, neither (a) nor (b)	1	4%
	Total	28	100%

Source: Field Survey Data, 2016

From Table 4.17 the data provided by the respondents indicates that only 9 out of the 28 respondents were aware of the Lean philosophy prior to answering the questionnaire which represents 32% of respondents. With this, it can be concluded that a lot more awareness is needed even among professionals in the built environment. 19 out of 20 respondents representing 90% who answered question 2, were of the view that the questionnaire has been educative to them. This concludes that the questionnaire survey has been of immense benefit in hammering the lean concept in construction to the respondents. 96% of respondents were of the view that “Lean Construction is beneficial to an Affordable Housing Scheme in Ghana” whereas 100% answered affirmatively that “Lean Construction Techniques could improve productivity in Affordable Housing delivery in Ghana” to questions 3 and 4 respectively. It can be concluded that by the responses to questions 3 and 4; the respondent who answered ‘No’ to question 3 might have been muddled to the question. Notwithstanding the latter and 14% of respondents who answered ‘No’ to question 6, it can be emphatically concluded that 98% of professionals in the built environment per the sample size agree that Lean Construction would be beneficial to the Affordable Housing Scheme in Ghana. The 96% of respondents who answered that “Applying techniques from manufacturing to construction is; *Possible (with adjustments)*” gave the following reasons:

“...it will depend on the kind of projects. For example, if the design and planning stage are done very well and if the buildings are repetitive.”

“...Manufacturing is well defined and product oriented than construction hence due to the dynamic nature of construction applying lean techniques from manufacturing would only be possible with adjustments.

“...Because construction is unique in its own field”

From the analysis forgone it can be concluded that applying techniques from manufacturing is possible with adjustments to make it feasible.

Part D (Section 2), question 8 of the questionnaire was used to identify and assess the degree of significance of the possible benefits of lean construction concept to affordable housing schemes in Ghana. The answers to this question were assessed by using a Likert scale ranking from highly insignificant to highly significant.

Factor Analysis tool of IBM SPSS Version 20 was used to assess the underlying structure of the items listed on the questionnaire. From the results of the analyses using the Factor Analyses tool, the output of the relationship between the variables proved to be multicollinear (meaning the correlation between the variables are very high), as a result of this, the sample adequacy is not enough for Factor Analysis to effectively analyze the input data. It means that all the factors outlined in the questionnaire are almost 100% agreed to be significant or highly significant by the respondents. The dependency of the variables on each other is very high as displayed in the communalities in Table 4.18 below.

Table 4. 18 - Communalities of Benefits of Lean Construction to Affordable Housing Schemes

	Initial	Extraction
Improved process flow	1.000	0.856
Improvement of environment quality	1.000	0.825
Reduction in material usage	1.000	0.719
Reduction in energy consumption	1.000	0.651
Reduction in waste	1.000	0.595
Reduction in water usage	1.000	0.914
Improvement in health and safety	1.000	0.684
Design optimisation	1.000	0.735
Continuous improvement	1.000	0.870
Reduce cost and lead time	1.000	0.874
Improvement in quality	1.000	0.905
	1.000	0.852

	1.000	0.872
Increased productivity	1.000	0.895
Construction project value enhancement	1.000	0.811
Higher return on assets	1.000	0.723
Improved corporate image	1.000	0.674
Improvement in sustainable innovation	1.000	0.861
Increased levels of organisational commitment	1.000	0.748
Employee autonomy	1.000	0.725
Performance improvement	1.000	0.768
Client satisfaction	1.000	0.861
Enhanced organisational knowledge management	1.000	0.912
Increased compliance with customers' expectation	1.000	0.747

Extraction Method: Principal Component Analysis.

Source: Field Survey Data, 2016

From the table of communalities above, some variables loaded as high as 90% and the lowest loaded almost 60%. The output from the factor analyses interpret that, there is no possible underlying structure of the variables loaded. The variables are all very important and none of them can be underestimated.

The twenty-four benefits listed (as shown in the questionnaire in Appendix A) were all agreed to be the good by-product of effective application of Lean Construction Concept in Affordable Housing delivery in Ghana.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter concludes the study that has been performed in connection with the Enablers of Lean Construction Concept to the Affordable Housing Scheme in Ghana. This is done by assessing and comparing the objectives set against the results that were achieved in the advancement of this study. The end of this chapter highlights few recommendations for further research.

5.2 AIM AND OBJECTIVES REVISIT

In order to assess and compare the results obtained from the research on the objectives that have been set, so it is essential to re-highlight the aim and objectives of the study. With regards to this research work, the aim of the study is to identify and assess the enablers of lean construction to the execution of Affordable Housing Schemes in Ghana.

The objectives of the research are outlined as follows:

- 1) To assess the perception of stakeholders on the concept of Affordable Housing;
- 2) To identify the potential barriers to the application of the Lean Construction Concept in Ghana; and
- 3) To identify the Enablers or Drivers of Lean Construction Concept in Affordable Housing Schemes in Ghana;

5.3 EVALUATION ON OBJECTIVES AND AIM OF THE STUDY

In order to ascertain whether the study has successfully achieved its objectives, a thorough assessment on each aspect of the achievements from this study has to be

performed against the objectives. The assessment of the objectives as addressed in the study are as follows:

5.3.1 Objective No. 1 - To assess the perception of stakeholders on the concept of Affordable Housing

The assessment of this objective was performed in Chapter 4, through the collection and assessment of data collected in the questionnaire survey. From the analysis conducted in Chapter 4 it can be concluded that stakeholders in the construction industry are aware of the Affordable Housing Scheme in Ghana. The analysis also proved that 79% of respondent agreed to the definition of Affordable Housing as: *“housing that assists lower income households in obtaining and paying for appropriate housing without experiencing undue financial hardship”* (Milligan *et al.* 2004). The researcher agrees with the respondents on this definition of the Affordable Housing Concept since it addresses the target group of people *“lower income households”* a payment plan or terms of payment *“in obtaining and paying”* the condition of the facility *“appropriate housing”* and states a sustainable critical factor *“without experiencing undue financial hardship”*. According to the researcher, this definition is by far the most appropriate definition of Affordable Housing. After reviewing various literature in Chapter 2, the following are some of the housing policies that would help to determine some policy forms that applies to the affordable housing concept:

- Tax policy;
- Housing finance / mortgage Policy;
- Construction Policy;
- Promotion of Real Estate Development Policy;
- Land Policy; and
- Rent Policy (Asamoah, 2014; UN Habitat, 2011; Andreasen *et al.* 2005; Ferguson and Navarrete, 2003).

The findings of the study reveals that professionals in the built environment agree that lean construction concept if employed to the affordable housing scheme in Ghana would result to optimization of construction resources, value maximization, waste minimization and above all lead to and overall cost reduction of the building.

5.3.2 Objective No. 2 - To identify the potential barriers to the application of Lean Construction Concept in Ghana

The assessment of this objective was performed in Chapter 4 with the use of the SPSS software to determine the reliability of the data collected through questionnaire survey. Principal component factor analysis with varimax rotation was conducted to assess the underlying structure for the 15 items of “Barriers to Application of Lean Construction Concept to Affordable Housing Schemes in Ghana” - Questionnaire. (The assumption of independent sampling was met; the assumption of normality, linear relationships between pairs of variables, and the variables’ being correlated at a moderate level were checked). Three factor headings were arrived at, though the items were designed to index four constructs: management related, construction related and design related.

After all the data passed the three tests, varimax rotation was conducted to assess the underlying potential barriers where factors were named, analyzed and the items were grouped as displayed in Table 4.10.

The barriers were further categorized under three main headings namely; management related, construction related and design related barriers.

To identify and overcome these obstacles identified in the future, strategies should be developed to find an applicable solution. This will require strong support and commitment of top management, including the dissemination of knowledge and awareness, training and the transformed perception of employee attitudes.

5.3.3 Objective No. 3 - To identify the Enablers or Drivers of Lean Construction

Concept in Affordable Housing Schemes in Ghana

The assessment of this objective was performed in Chapter 4 with the use of the SPSS software to determine the reliability of the data collected through questionnaire survey. Principal component factor analysis with varimax rotation was conducted to assess the underlying structure for the 16 items of “*Enablers for Implementing Lean Construction Concept in Affordable Housing Schemes in Ghana*”- Questionnaire. (The assumption of independent sampling was met. The assumption of normality, linear relationships between pairs of variables, and the variables’ being correlated at a moderate level were checked). Four factors were derived, based on the fact that the items were designed to index four constructs: ‘Leadership and Management related’, ‘Organizational and Cultural related’, ‘Resource, Skills and Expertise related’.

After all the data passed the three tests, varimax rotation was conducted to assess the underlying enablers where factors were named, analysed and the items were grouped into four main categories as displayed in Table 4.16.

Business plan and vision, top-management support, regular training of the workforce, development of a continuous improvement culture and system and process change management were among the highest ranked enablers of lean by the respondents.

As a result of the analysis derived from Part D (Section 2) of the questionnaire survey, it can be concluded that there are still a greater number of construction stakeholders who are not aware of the Lean Construction philosophy. Respondents largely agreed to the statement that the questionnaire has been educative in introducing them to the Lean philosophy. Furthermore, professionals in the built environment per the survey generally agree that Lean Construction would be beneficial to the Affordable Housing Scheme in Ghana.

By appreciating the objectives that have been achieved, the study aim has therefore been successfully achieved and materialized.

KNUST



5.4 LIMITATION OF STUDY

There were two major limitations in this study which were time limitation and cost limitation.

5.4.1 Time Limitation

Time allotted by the university was limited to get all the requisite data needed from the respondents.

5.4.2 Cost Limitation

Since the researcher had no other financial aid other than his personal funds, travelling to other parts of the country to collect the required data was a challenge. Hence, postage (e-mail) of questionnaires was done to cover professionals in the entire country but the response rate from the emails sent was generally low.

5.5 RECOMMENDATIONS

Two parts of recommendations are developed by the researcher that are based on findings from the study and proposals for future research.

5.5.1 Recommendations Based on Findings

Having examine the results of the findings of this research and the scope tackled, some recommendations are listed below to develop and efficient the implementation of the lean approach in the delivery of an affordable housing scheme in Ghana:

Government policies and social issues should be considered in developing and implementing the Affordable Housing Scheme in Ghana.

The commitment of top management in the integration of lean techniques in business processes and decision-making is key for reaping the enormous benefits of lean approach.

Lean transition team's organization and development of vision and guiding principles while being responsible for Lean impact assessment must be conducted within the organization. Lean implementation areas and priority can be decided based on business strategies.

Inclusion of a lean business strategy must be understood by organizations in order to take advantage of its benefits.

5.5.2 Recommendations for Future Research

- 1) The study identified barriers hindering the application of lean and the success factors to implement lean in affordable housing schemes, but a framework was not intended to provide a course of action to address these problems and enablers (success factors) identified in the study. Future research should be carried out to investigate how these barriers can be assessed and the development of a framework to provide steps on implementation guidelines and procedures to follow for a sustainable LCC in the Ghanaian construction industry.
- 2) There is scope for further development in qualitatively analyzing the success factors as highlighted in this study to understand the factors in their uniqueness as part of a particular context and the interactions there.
- 3) There is more scope for further research in the formulation of a framework for a cost-benefit analysis on construction industries implementing the lean philosophy in their operations.

REFERENCES

- Abdelhamid, T. S. (2004) *The Self-Destruction And Renewal Of Lean Construction Theory: A Prediction From Boyd's Theory*. s.l., s.n.
- Achanga, P.C. (2007) Development of an impact assessment framework for lean manufacturing within SMEs.
- Adjei, K. O., Fobiri, G. & Owiredu, G. K. (2015) Policies And Barriers in The Provision of Affordable Housing in Ghana. *African Journal of Applied Research .(AJAR) Journal*, January, 1(1), pp. 159-169.
- Agbola, T. (1998) *The Housing of Nigerians: A Review of policy Development and Implementation. Research Report 14*, Ibadan, Nigeria: Development Policy Centre.
- Agbola, T. & Alabi, M. (2000) *Sustainable Housing Delivery, Lesson from International Experience. Paper presented at the National workshop on Sustainable Housing Delivery in Nigeria; Challenges for public/private partnership*, Sheraton Hotel Abuja revising 5-7 June, 2000: s.n.
- Ahadzie, D. K. (2007) *Model for predicting the performance of Project Managers at the construction phase of the Mass House Building Projects*, Wolverhamton, United Kingdom: http://wlv.openrepository.com/wlv/bitstream/2436/15393/2/Ahadzie_PhD%20thesis.pdf.
- Ahrens, T. (2006) *Lean production: Successful implementation of organisational change in operations instead of short term cost reduction efforts*, s.l.: Lean Alliance.
- Alarcón, L.F. and Serpell, A. (1996, August) Performance measuring, benchmarking and modeling of project performance. In *5th International Conference of the International Group for Lean Construction*.
- Alarcón, L.F., Diethelm, S., Rojo, O. and Calderon, R. (2005) Assessing the impacts of implementing lean construction International Group for Lean Construction. Symposium conducted at the meeting of the International Group for Lean Construction, (IGLC)-13, Sydney, Australia.
- Alinaitwe, H. M. (2009) Prioritizing Lean Construction Barriers in Uganda's Construction. *Journal of Construction in Developing Countries*, Issue 14, pp. 15-30.
- Amiriashad, N. & Lerma, B. T. (2015) *Sustainable Lean Construction: Processes to reduce nuisances for society created by an urban construction site during the production phase*, s.l.: Master of Science Thesis in the Master's Programme International Project Management.
- Anuta, J. (2014) Residential construction citywide jumps 50%. New York City, New York, United States of America. *Crain's New York Business*.

- Anvari, A., Zulkifli, N., Yusuff, R.M., Hojjati, S.M.H. and Ismail, Y. (2011) A proposed dynamic model for a lean roadmap. *African Journal of Business Management*, 5(16), p.6727.
- Australia, E. (2012) *Recommended Practices for the Application of LEAN Construction Methods to Building New Australian LNG Capacity*, s.l.: s.n.
- Aveyard, H. (2007) *Doing a Literature Review in Health and Social Care: A Practical Guide*. England: McGraw-Hill, Open University Press.
- Ayarkwa, J., Agyekum, K., Adinyira, E. & Osei-Asibey, D. (2012) Perspectives for the implementation of lean construction in the Ghanaian construction industry. *Journal of Construction Project Management and Innovation*, 2(2), pp. 345359.
- Ayarkwa, J., Dansoh, A. & Amoah, P. (2010) Barriers to Implementation of EMS in Construction Industry in Ghana. *International Journal of Engineering Science*, 2(4), pp. 37-45.
- Aziz, R.F. and Hafez, S.M. (2013) 'Applying lean thinking in construction and performance improvement', *Alexandria Engineering Journal*, 52(4), pp. 679–695.
- Badurdeen, A. (2006). <http://EzineArticles.com/145534>. [Online].
- Ballard, G. (2000) *Lean Project Delivery System*, s.l.: Lean Construction Institute.
- Ballard, G., Tommelein, I., Koskela, L. and Howell, G. (2002) Lean construction tools and techniques. *Chapter, 15*, pp.227-255.
- Ballard, G. & Howell, G. A. (2003) Lean project management. *BUILDING RESEARCH & INFORMATION* (2003) 31(2), 119–133.
- Banuelas, R. & Anthony, J. (2002) Critical success factors for the successful implementation of six sigma projects in organisations. *The TQM Magazine*, 14(2), pp. 92-99.
- Bartlett, J. E., Kotrlik, I. J. W. & Higgins, C. C. (2001) Organizational Research: Determining Appropriate Sample Size in Survey Research. *Information Technology, Learning, and Performance Journal*, 19(1), pp. 43-50.
- Begum, R. A., Siwar, C., Pereira, J. J. & Jaafar, A. H. (2006) Implementation of waste management and minimization in the Malaysian construction industry. *Conversation and Recycling*, Issue 51, pp. 190-202.
- Bernard, H. R. (2000) *Social Research Methods*. London: Sage Publication.
- Bertelsen, S. (2002). *Bridging the Gaps – Towards a Comprehensive Understanding of Lean Construction*. s.l., s.n.
- Blakey, R. (2008) *An Introduction to Lean Construction*, s.l.: The Lean Construction Institute.

- Boamah, N. (2010) Housing Finance in Ghana: Can Community Mortgage Cooperatives Provide a Panacea?. *Ghana Journal of Development Studies*, 7(1).
- Boamah, N. A. (2010) Housing Affordability in Ghana: A focus on Kumasi and Tamale. *Ethiopian Journal of Environmental Studies and Management*, 3(3), p. 1.
- Boyer, M. & Sovilla, L. (2003) How to identify and remove the barriers for a successful lean implementation. *Journal of Ship Production*, 19(2), pp. 116-120.
- Burgess, T. F. (2001) *Guide to the Design of Questionnaires: A general introduction to the design of questionnaires for survey research*. 1.1 ed. s.l.:University of Leeds.
- Buss, K. L. (2011) *Regulatory Barriers to Affordable Housing: An Analysis of the Effects of Local Land Use Regulations on Housing Costs in the Greater Sacramento Area*, . California State University, Sacramento: Master's degree Thesis.
- Chepsiror, E. (2013) *The Challenges of Housing Development for the Low Income Population in Kenya; A Case of Eldoret Town*, University of Nairobi, Kenya: Post Graduate Diploma Thesis.
- CHF International, (2004) *Strategic Assessment of the Affordable Housing Sector in Ghana*. [Online] Available at: www.globalcommunities.org [Accessed 5 May 2016].
- Coakes, S. J., Steed, L. & Ong, C. (2010) *SPSS: analysis without anguish: version 17 for Windows*. s.l.:John Wiley and Sons, Australia.
- Coffey, M. (2000, July). Developing and maintaining employee commitment and involvement in lean construction. In *Proceedings of the 8th annual conference of the International Group for Lean Construction* (pp. 17-19).
- Cohen, L., Manion, L. & Morrison, K. (2000) *Research Methods in Education*. 5th ed. London: Routledge Falmer.
- Construction Industry Institute (CII) (2007) Lean Implementation at the Project Level. *The University of Texas at Austin, 2007, Research Summary*, Volume 234.
- Conte, A. S. I. (2002) *Lean Construction: From Theory To Practice*. Gramado, Brazil, s.n.
- Cowton, C. J. (1998) The Use of Secondary Data in Business Ethics Research. *Journal of Business Ethics*, 17(4), pp. 423-434.
- Creswell, J. W. & Clark, V. L. P. (2007) *Designing and Conducting Mixed Methods Research*. Calif, University of Nebraska-Lincoln: Sage Publications, Inc.
- Crute, V., Wade, Y., Brown, S. & Graves, A. (2003) Implementing Lean in aerospace-Challenging the assumptions and understanding the challenges. *Technovation*, 23(12), pp. 917-928.

- Dave, B., Koskela, L., Kiviniemi, A. & Tzortzopoulos, P. (2013) *Lean construction and BIM*, London: s.n.
- Dillman, D. A. (2000) *Mail and Internet Surveys, The tailored design method*. 2 ed. New York: Wiley.
- EC, (2010) *European Textbook on Ethics in Research*. Brussels: European Commission Directorate-General for Research.
- Enache-Pommer, E., Horman, M. J., Messner, J. I. & Riley, a. D. (2010) *A Unified Process Approach to Healthcare Project Delivery: Synergies between Greening Strategies, Lean Principles, and BIM*. s.l., s.n.
- Eriksson, P. E. (2010) Improving construction supply chain collaboration and performance:a lean construction pilot project. *Volume 15 · Number 5 · 394–403*.
- Fellows, R. & Liu, A. (2008) *Research Methods for Construction*. 3 ed. Oxford: Blackwell Publishers Ltd.
- Field, A. (2005) *Discovering Statistics Using SPSS*. 2nd ed. London: Sage Publications.
- Fontanini, P. S. P. & Picche, F. A. (2004) *VALUE STREAM MACRO MAPPING-A CASE STUDY OF ALUMINUM WINDOWS FOR CONSTRUCTION SUPPLY CHAIN*. s.l., s.n.
- Forbes, L. H., Ahmed, S.M. and Barcala, M. (2002, November). Adapting lean construction theory for practical application in developing countries. In *Proceedings of the first CIB W107 International Conference: Creating a Sustainable Construction Industry in Developing Countries (Eds. Division of Building Technology, CSIR), Stellenbosch, South Africa* (pp. 11-13).
- Forbes, L. & Ahmed, S. (2004) Adapting Lean Construction for Developing Nations. *Second LACCEI International Latin American and Caribbean Conference for Engineering and Technology (LACCEI'2004) "Challenges and Opportunities for Engineering Education, Research and Development"*, 2-4 June, 2004.
- Ferguson, B. and Navarrete, J. (2003). New approaches to progressive housing in Latin America: A key to habitat programs and policy. *Habitat International*, 27(2), pp.309-323.
- Franko, J. (2009) *Barriers to Affordable Housing*. National Council for Policy Analysis, s.l.: Brief Analysis No. 680.
- Gabriel, M., Jacobs, K., Arthurson, K., Burke, T., Yates, J. (2005) *Conceptualising and measuring the housing affordability problem, National Research Venture 3: Housing affordability for lower income Australians Research Paper No. 1*, Australia: Australian Housing and Urban Research Institute.
- Garrett, D. F. & Lee, J. (2011) *Lean Construction Submittal Process—A Case Study*. Taylor & Francis Ltd.

- Glaeser, E. L. & Gyourko, J. (2003) The Impact of Building Restrictions on Housing Affordability. *Economic Policy Review*, pp. 21-39.
- Gleeson, F. a. T. J. (2007) *Lean construction in the corporate world of the U.K. construction industry*, s.l.: University of Manchester, School of Mechanical, Aerospace, Civil and Construction Engineering.
- Glenn Ballard, N. H. a. T. Z. (2003) Learning to see work flow: an application of lean concepts to precast concrete fabrication. *Engineering, Construction and Architectural Management Volume 10 . Number 1*.
- Green, S.D. (2002) The human resource management implications of lean construction: critical perspectives and conceptual chasms. *Journal of Construction Research*, 3(01), pp.147-165.
- Green, S. D. & May, S. C. (2005) Lean construction: Arenas of enactment, models of diffusion and the meaning of 'leanness'. *Building Research and Information*, 33(6), pp. 498-511.
- H. Randolph Thomas, M., Horman, M. J., Souza, U. E. L. d. & Zavr'ski, a. I. (2002) Reducing Variability to Improve Performance as a Lean Construction Principle. *Journal of Construction Engineering and Management / March/April* .
- Henson, R. K. & Roberts, J. K. (2006) Use of exploratory factor analysis in published research: Common errors and some comment on improved practice. *Educational and Psychological Measurement*, 66(3), pp. 313-416.
- Holweg, M. (2007) The genealogy of lean production. *Journal of Operations Management* 25 (2007) 420–437.
- Hook, M. & Stehn, L. (2008) Applicability of lean principles and practices in industrialized housing production. *Construction Management and Economics (October) 26*, 1091–1100.
- Howell, G. A. (1999) *What is Lean Construction*. California, USA, University of California, Berkeley, CA, USA.
- Howell, G. & Lichtig, W. (2008) *Lean Construction Opportunities Ideas Practices*. s.l.:s.n.
- Jacobs, G. F. (2010) *Review Of Lean Construction Conference Proceedings And Relationship To The Toyota Production SystemY Framework*. Fort Collins, Colorado: s.n.
- Jiboye, A. B. (2011) Achieving Sustainable Housing Development in Nigeria: A Critical Challenge to Governance. *International Journal of Humanities and Social Science*, 1(9 [Special Issue – July 2011]).
- Johansen, E. and Walter, L. (2007) Lean construction: Prospects for the German construction industry. *Lean Construction Journal*, 3(1), pp.19-32.

- Katz, B. & Allen, K. (1999) Help Wanted, Connecting Inner-City Job Seekers with Suburban Jobs. *America at Work, Brooking Review*, pp. 31-35.
- King, P. (2001) *Understanding Housing Finance*, London: Routledge: s.n.
- Ko, C.-H., Wang, W.-C. & Kuo, a. J.-D. (2011) Improving Formwork Engineering Using the Toyota Way. *Journal of Engineering, Project, and Production Management* 1(1), 13-27.
- Koskela, L. (1992) *Application Of The New Production Philosophy To Construction*, Finland: Stanford University.
- Kpamma, E. Z. (2009) *The practice of lean thinking at the Pre-Contract stage of building construction projects by selected Ghanaian firms*, s.l.: MSc Thesis, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Lafarge, E. (2010) *Vision for Egyptian Market Trends. GTM/CI Capital Real Estate Egypt Conference II*. Cairo, s.n.
- Laquatra, J. & Potter, G. L. (2000) *Building a Balance: Housing Affordability and Environmental Protection in the USA*, s.l.: Electronic Green Journal, 1(12), 114.
- Liker, J. (2004) *The Toyota Way, 14 management principles from the world greates*, New York: Mc-Graw Hill.
- Liker, J. K. (2004) *The Toyota Way*. McGraw-Hill: s.n.
- Lund Research Ltd, (2012). *Laerd dissertation*. [Online]
Available at: <http://dissertation.laerd.com/copyright.php> [Accessed 8 June 2016].
- Malpezzi, S. & Mayo, S. K. (1987) The Demand for Housing in Developing Countries: Empirical Estimates from Household Data. *Economic Development and Cultural Change*, 35(4), pp. 687-721.
- Martel, A. (2013) *Getting to Yes: Overcoming Barriers to Affordable Family Friendly Housing in inner Melbourne: Literature review* , s.l.: On behalf of Melbourne University Research Team.
- Mastroianni, R. & Abdelhamid, T. (2003) "The challenge: The impetus for change to lean project delivery". *11th Conf. of Int. Group for Lean Construction, Blacksburg, VA*. 418-426..
- Maturana, S., Alarcón, L. F., Gazmuri, P. & Vrsalovic, a. M. (2007) On-Site Subcontractor Evaluation Method Based on Lean Principles and Partnering Practices. *JOURNAL OF MANAGEMENT IN ENGINEERING* © ASCE / APRIL
- Milligan, V., Phibbs, P., Fagan, K. & Gurran , N. (2004) *A Practical Framework for Expanding Affordable Housing Services in Australia: Learning from Experiencee, Final Report No. 65*, Australia: Australian Housing and Urban Research Institute.

- Milligan, V., Phibbs, P., Gurran, N. & Fagan, K. (2007) *Approaches to Evaluation of Affordable Housing Initiatives in Australia, National Research Venture 3: Housing affordability for lower income Australians Research Paper No. 7*, s.l.: Australian Housing and Urban Research Institute.
- Mingers, J. & Gill, A. (1997) *Multimethodology: The Theory and Practice of Combining Management Science Methodologies*. West Sussex, England: John Wiley & Sons.
- Moser, C. & Kalton, G. (1971). *Survey Methods in Social Investigation*. London: Heinemann Educational Books Limited.
- Mossman, A. (2009) Why isn't the UK construction industry going lean with gusto. *Lean Construction Journal*, 5(1), pp.24-36.
- Mossman, A. (2012) *Last Planner – collaborative short-term production planning*, s.l.: s.n.
- Mostafa E. Shehata, K. M. E.-G. (2011). Towards improving construction labor productivity and projects' performance. *Alexandria Engineering Journal* 50, 321–330.
- Naoum, S. G. (1998) *Dissertation Research and Writing for Construction Students*. London: Elsevier Butterworth Publications.
- Nesensohn, C., Demir, S.T. and Bryde, D.J. (2012) Developing a 'True North' Best Practice Lean Company with Navigational Compass. In *Proc., IGLC*.
- Nsiah-Gyabaah, K. (2013) *The Urban Housing Challenge and Prospects for Meeting the Housing Needs of the Urban Poor in Ghana. Proceedings of National Housing Conference, Building and Road Research Institute*. s.l., s.n.
- O' Del, W. O., Smith, M. & White, D. (2004). Weaknesses in Current Measures of Housing Needs. *Housing and Society*, 31(1), pp. 29-40.
- O'Connor, R. & Swain, B. (2013). *Lean tools and techniques-an introduction*, s.l.: CIRIA.
- Olatubara, C. O. (2002). *Housing Policy and its Impact on the Populace: The Elusive Solution to Housing Problem. Being a paper presented at the continuing Professional Development Workshop on Housing Policy and Its Impact on the Populace, Organized by the, Ogun State Branch: Nigeria Institution of Estate Surveyors and Valuers*.
- Owusu, S. E. & Boapeah, S. N. (2003). Housing Policy in Ghana: Experiences and Interventions for Public/Private Sector Support Systems. *Bi-Annual Journal of the Building and Road Research Institute (CSIR), Ghana*.
- Ogunbiyi, O.E. (2014). *Implementation of the lean approach in sustainable construction: a conceptual framework* (Doctoral dissertation, University of Central Lancashire).

- Payne, M. (2002). *Tenure and the Law: the Legality of Illegality and the Illegality of Legality*. In Payne, G. (Ed.). *Land, rights and innovation: improving tenure security for the urban poor*, London: ITDG Publishing.
- Picchi, F. & Granja, A. (2004). Construction sites: using lean principles to seek broader implementation. *12th International Group for lean Construction Annual Meeting, Elsinore*, 1(1), pp. 1-1.
- Polat, G. & Ballard, G. (2004). Waste in Turkish Construction- Need for Lean Construction Techniques. *Proceedings of the 12th Annual Conference of the International Group for Lean Construction IGLC-12*, August, pp. 488-501.
- Polit, D. F. & Hungler, B. P. (2001). *Essentials of nursing research: Methods, Appraisal and Utilization*. 5 ed. s.l.:J. B.Lippincott Company.
- Radnor, Z., Walley, P., Stephens, A., & Bucci, G. (2006). Evaluation of the lean approach to business management and its use in the public sector. *Edinburgh, Office of Chief Researcher, Scottish Executive*.
- Radnor, Z. & Walley, P. (2008). "Learning to Walk Before We Try to Run: Adapting Lean for the Public Sector". *Public Money and Management*, 28(1), pp. 13-20.
- Refaat H. Abdel-Razek, H. A. E. M. M. A.-H. (2007) Labor productivity: Benchmarking and variability in Egyptian projects. *International Journal of Project Management* 25,189–197.
- Rother, M. (2010). Toyota kata. *MacGraw Hill*.
- Sacks, R., Koskela, L., Dave, B. A. & Owen, a. R. (2010) Interaction of Lean and Building Information Modeling in Construction. *Journal of Construction Engineering and Management* © ASCE / September .
- Sacks, R., Treckmann, M. & Rozenfeld, O. (2009) Visualization of Work Flow to Support Lean Construction. *Journal of Construction Engineering and Management* © ASCE / December.
- Salem, M., Solomon, J., Genaidy, A. & and I. Minkarah, M. (2006) Lean Construction: From Theory to Implementation. *Journal of Management in Engineering* © ASCE / October.
- Samalia Adamu, R. A. H., (2012). Lean Construction Techniques Implimentation in Nigeria Construction Industry. *Canadian Journal on Environmental, Construction and Civil Engineering Vol. 3, No. 4, May* .
- Santor, D.A., Haggerty, J.L., Lévesque, J.-F., Burge, F., Beaulieu, M.-D., Gass, D. and Pineault, R. (2011) 'An overview of Confirmatory factor analysis and item response analysis applied to instruments to evaluate primary healthcare', 7(Spec Issue).
- Saunders, M., Lewis, P. & Thornhill, A. (2007) *Research methods for business students*. 4 ed. Harlow: Financial Times Prentice.

- Schenck, J. (1998) CPFR: stitching together the partnership. *Apparel Industry Magazine*, 59(8), pp.72-3.
- Senge, P., Kleiner, A. and Roberts, C.R., R., Roth, G. & Smith, B. (1999). *The dance of change: The challenges to sustaining momentum in learning organizations*.
- Sicat, S. (2012). <http://www.fgould.com/north-america/articles/lean-approach/>. [Online] [Accessed 27 April 2013].
- Sila, T. M. & Olweny, T. (2014) Financial Determinants Affecting the Cost of Houses in Kenya: A Case Study of National Housing Corporation.. *International Journal of Business & Law Research*, 2(4), pp. 1-16.
- Simonsson, P., Björnfot, A., Erikshammar, J. & Olofsson, & T. (2012) 'Learning to see' the Effects of Improved Workflow in Civil Engineering Projects. *Lean Construction Journal*: pp 35-48.
- Singer, E. (2008). Ethical Issues in Surveys. In: E. D. de Leeuw, J. J. Hox & D. A. Dillman, eds. *International Handbook of Survey Methodology*. s.l.:European Association of Methodology, pp. 78- 96.
- Smith, S. (2013) *Lean benefits realisation management*, London: CIRIA, C727.
- Thomas, H. R., Michael J. Horman, M., R. Edward Minchin Jr., M. and Dong Chen, M. (2003) Improving Labor Flow Reliability for Better Productivity as Lean Construction Principle. *Journal of Construction Engineering and Management* © ASCE / May/June.
- Thompson, B. (2004) *Exploratory and Confirmatory Factor Analysis: Understanding concepts and applications*. Washington, DC: American Psychological Association.
- Tommelein, R. J. A. a. I. D. (2002) *Value Stream Analysis of Construction Supply Chains: Case Study on Pipe Supports Used in Power Plants*. s.l., s.n.
- UN-HABITAT , 2006. *Ghana Country Report. West Africa High-level peer exchange on Government Enablement of Private Sector lending for Affordable Housing*, , Accra: UN-HABITAT .
- UN-HABITAT, 2011. *Ghana Housing Profile*, Accra: UN-HABITAT.
- US Department of Housing and Urban Development, 2012. *Affordable Housing*. [Online] Available at: http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/ [Accessed 6 May 2016].
- Vieira, L. C., Souza, L. O. D. & Amaral, M. T. (2012) *Application of the Rapid Lean Construction-Quality Rating Model to Engineering Companies*. s.l., s.n.
- Wallace, J.E. (1995) 'Financing affordable housing in the United States', *Housing Policy Debate*, 6(4), pp. 785–814. doi: 10.1080/10511482.1995.9521205.

- Williams, B., Onsmann, A. & Brown, T. (2010) Exploratory factor analysis: A five-step guide for novices. *Journal of Emergency Primary Health Care (JEPHC)*, 8(3), pp. 1-9.
- Wodalski, M. J., Thompson, B. P., Whited, G. & Hanna, A. S. (2011) *Applying Lean Techniques in the Delivery of Transportation Infrastructure Construction Projects*, s.l.: s.n.
- Womack, J.P. and Jones, D.T. (1996) Lean thinking: Banish waste and create wealth in your organisation. *Simon and Shuster, New York, NY*, 397.
- Woodward, P.J.F. (2001) 'Procurement systems — A guide to best practice in construction', *International Journal of Project Management*, 19(7), p. 432. doi: 10.1016/s0263-7863(00)00046-6.
- Yong-Woo Kim, A. & Bae, a. J. (2010) Assessing the Environmental Impacts of a Lean Supply System: Case Study of High-Rise Condominium Construction in Korea. *Journal of Architectural Engineering* © ASCE / December.
- Zettel, G. (2008) *Transforming Turner Projects with Last Planner System*, s.l.: Turner Construction Company.
- Zimmer, S. A. (2005) Application of Lean Manufacturing Principles to Construction. *Lean Construction Journal*, Vol 2.

APPENDIX

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY COLLEGE OF ART AND BUILT ENVIRONMENT DEPARTMENT OF BUILDING TECHNOLOGY SURVEY QUESTIONNAIRES

Respected Sir/Madam

As a part of Academic Research, I would like to elicit your view on Lean Construction Application Concept in Affordable Housing Delivery in Ghana. I am a Master of Science (Construction Management) student of the Department of Building Technology, Kwame Nkrumah University of Science and Technology (KNUST). I am currently conducting a survey on the topic: **Enablers of Lean Construction Concept to Affordable Housing Schemes in Ghana**. Your valued assistance in answering this questionnaire will be much appreciated. I assure you of confidentiality and anonymity of all the responses you will provide. Thank you!

Please return or direct any enquiry to:

The Researcher:

Peter Kofi Kyere,

Supervisor:

Professor Joshua Ayarkwa

PART A: RESPONDENT'S PROFILE

Please tick [✓] or click in the box [☐] the answer where applicable for the following questions [✓]

1. What is your professional background?
 - a. Architect [☐]
 - b. Engineer (Building/Civil) [☐]
 - c. Project Manager [☐]
 - d. Quantity Surveyor [☐]
 - e. Procurement Manager/Officer [☐]
 - f. Others (Specify)
2. What is your highest educational attainment?
 - a. MBA/MSc/MPhil/PhD [☐]
 - b. PG. Dip. [☐]
 - c. Bachelor Degree(s) [☐]
 - d. Higher National Diploma (HND) [☐]
 - e. Others (specify)
3. What are your year(s) of experience in your area of work?
 - a. Between 0 – 5 years [☐]
 - b. Between 5 – 10 years [☐]
 - c. Between 10 – 15 years [☐]
 - d. Above 15 years [☐]
4. Are you a member of a professional body/bodies?
 - a. Yes [☐]
 - b. No [☐]
5. Which stage of Construction have you been involved in essentially?
 - a. Pre-Contract stage [☐]
 - b. Post-Contract stage [☐]
 - c. Construction stage [☐]

PART B: CONCEPTS AND MEANING OF AFFORDABLE HOUSING

1. In your own view or opinion, how do you understand the concept of Affordable Housing?

2. What are some of the factors that influence the concept of Affordable Housing Schemes?

- a. Social issues ☐
- b. Demography ☐
- c. Government policies ☐
- d.

Others (specify):

3. Please tick ☐ or click in the box ☐ which one of the following in your opinion best defines Affordable Housing?

- a. provision of ‘adequate shelter’ on a sustained basis ☐
- b. housing provided to those whose needs are not met by the open market’ ☐
- c. housing that medium income residents may afford according to their country and region ☐
- d. housing that assists lower income households in obtaining and paying for appropriate housing without experiencing undue financial hardship ☐
- e. the housing in which low or middle income households would be able to afford with no more than 30% of their income ☐

4. Do you know of any Housing Scheme in Ghana?

- a. Yes ☐ No ☐

The following are a list of defined terms for better understanding while answering the questions that follow:

Term	Definition
Lean Philosophy	The main purpose of ‘lean’ is to maximize value and minimize waste by using the appropriate lean techniques.
Lean Construction	Is a production management based approach to project delivery – a new way to design and build capital facilities.
Lean Production Construction	Production philosophy originating in manufacturing focused on in process flows.

Waste	Any operation or activity that takes time and resources but does not add value to the product or service sold to the customer.
Value	When a product or service has been perceived or appraised to fulfil a need or desire as defined by the customer.
Value stream	“Everything that goes into” creating and delivering the “value” to the endcustomer.
Flow	The progressive achievement of tasks and/or information as it proceeds along the value stream.
Pull	It means producing as per the customers need or in-line to the demand of the customer (what the customer wants when the customer wants).
Perfection	Seek perfection all the time through continuous improvement and implementing appropriate methods to the process.
Just-In-Time (JIT)	Just in Time means producing or providing only what is needed, when it is needed, and in the amount needed – no more, no less.
Drivers	Drivers in the context of this study refer to critical success factors required by organizations to adopt lean

PART C: BARRIERS TO APPLICATION OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES.

1. The following questions are a list of **Barriers** to the successful implementation or application of **Lean Construction Concept to Affordable Housing Schemes** in Ghana. In your own assessment, how significant are these factors, rate them on a 5-point Likert scale.

Agreement legend

1. Highly insignificant 2. Insignificant 3. Undecided 4. Significant 5. Highly Significant

BARRIERS TO APPLICATION OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES.					5-Point Likert Scale				
					1	2	3	4	5
<u>MANAGEMENT RELATED</u>									

1.	Lack of customer and production focus	☐	☐	☐	☐	☐
2.	Lack of adequate lean awareness/ understanding	☐	☐	☐	☐	☐
3.	Lack of training	☐	☐	☐	☐	☐
4.	Fragmentation of profession	☐	☐	☐	☐	☐
5.	Absence of long term planning	☐	☐	☐	☐	☐
6.	Ineffective management practices	☐	☐	☐	☐	☐
<u>CONSTRUCTION RELATED</u>						
7.	Quality assessment focus on conformance	☐	☐	☐	☐	☐
8.	Fragmentation of supply chain	☐	☐	☐	☐	☐
9.	“Wait and See” attitude	☐	☐	☐	☐	☐
10.	Ineffective factory production	☐	☐	☐	☐	☐
11.	Ineffective management practices	☐	☐	☐	☐	☐
12.	Non application of Just-In-Time (JIT) delivery of materials on site	☐	☐	☐	☐	☐
<u>DESIGN RELATED</u>						
13.	Procurement method	☐	☐	☐	☐	☐
14.	Inaccurate design among professionals (C&S, M&E, Arch.)	☐	☐	☐	☐	☐
15.	“Cut and Paste” from previous project	☐	☐	☐	☐	☐
<u>OTHER(S) RELATED</u>						
16.		☐	☐	☐	☐	☐
17.		☐	☐	☐	☐	☐
18.		☐	☐	☐	☐	☐

PART D: ENABLERS OF LEAN CONSTRUCTION CONCEPT TO AFFORDABLE HOUSING SCHEMES IN GHANA.

Section 1

1. On a 5-point Likert scale, can you kindly rate the following success factors which drives the LCC in Affordable Housing Schemes in Ghana?

Agreement legend

1. Highly insignificant 2. Insignificant 3. Undecided 4. Significant 5. Highly Significant Other(s) specify

	Identify which, in your opinion are the significant drivers/ enablers for implementing Lean Construction Concept in Affordable Housing Schemes in Ghana.	5-Point Likert Scale
--	---	-----------------------------

		1	2	3	4	5
	Leadership and management factors					
1.	Management commitment and support	☐	☐	☐	☐	☐
2.	Customer focus and integration	☐	☐	☐	☐	☐
3.	Effective planning	☐	☐	☐	☐	☐
4.	System and process change management	☐	☐	☐	☐	☐
5.	Communication and coordination between parties	☐	☐	☐	☐	☐
6.	Review of performance/progress towards targets	☐	☐	☐	☐	☐
7.	Business plan and vision	☐	☐	☐	☐	☐
8.	Monitoring, evaluation and reporting of performance	☐	☐	☐	☐	☐
	Organizational cultural factors					
9.	Integration of team and end to end supply chain	☐	☐	☐	☐	☐
10.	Adoption of a continuous improvement culture	☐	☐	☐	☐	☐
11.	Benchmarking of suppliers against each other	☐	☐	☐	☐	☐
12.	Wide adoption of lean and sustainability concepts	☐	☐	☐	☐	☐
	Resource, skills and expertise factors					
13.	Regular training of workforce	☐	☐	☐	☐	☐
14.	Understanding of lean benefits on affordable housing concept	☐	☐	☐	☐	☐
15.	Good working environment	☐	☐	☐	☐	☐
16.	Teamwork and composition	☐	☐	☐	☐	☐

Section 2

- Are you aware or conversant with Lean Construction Principles prior to answering this questionnaire?
 - Yes ☐
 - No ☐
- If NO, has this questionnaire been educative to you?
 - Yes ☐
 - No ☐
- Do you think Lean Construction is beneficial for an Affordable Housing Scheme in Ghana?
 - Yes ☐
 - No ☐
- Do you think that Lean Construction Techniques could improve productivity in Affordable Housing delivery in Ghana?
 - Yes ☐
 - No ☐

5. Do you think that Lean Construction Techniques when used at site level could generate cost savings?
- a. Yes ☐ b. No ☐
6. Do you think Lean/JIT material supplies are a suitable solution in Affordable Housing delivery in Ghana?
- a. Yes ☐ b. No ☐
7. Which statement is in your opinion is closer to the truth:
Applying techniques from manufacturing to construction is
- a. Possible (with adjustments) ☐
- b. Is like fitting a round pole in a square hole ☐
- c. None of the above mentioned, neither (a) nor (b) ☐ Reasons

8. How would the under listed benefits of Lean Construction Concept impact on the Affordable Housing Scheme in Ghana?

Kindly Rate them on the 5-point Likert scale that follows.

Agreement legend

1. Strongly disagree 2. Disagree 3. Undecided 4. Agree 5. Strongly agree

Benefits of Lean Construction Techniques in Affordable Housing Schemes in Ghana		5-Point Likert Scale				
		1	2	3	4	5
	<u>ENVIRONMENTAL BENEFITS</u>					
i.	Improved process flow	☐	☐	☐	☐	☐
ii.	Improvement of environmental quality	☐	☐	☐	☐	☐
iii.	Optimum material usage	☐	☐	☐	☐	☐
iv.	Reduction in energy consumption	☐	☐	☐	☐	☐
v.	Reduction in waste	☐	☐	☐	☐	☐
vi.	Optimum water usage	☐	☐	☐	☐	☐
vii.	Improvement in health and safety	☐	☐	☐	☐	☐

viii.	Design optimisation	☐	☐	☐	☐	☐
ix.	Continuous improvement	☐	☐	☐	☐	☐
	<u>ECONOMIC BENEFITS</u>					
x.	Reduced cost and lead time	☐	☐	☐	☐	☐
xi.	Improvement in quality	☐	☐	☐	☐	☐
xii.	Improved integration of trades enabling optimisation of the way resources are deployed	☐	☐	☐	☐	☐
xiii.	Reduction in over-ordering of materials and reduced on-site transportation	☐	☐	☐	☐	☐
xiv.	Increased productivity	☐	☐	☐	☐	☐
xv.	Construction project value enhancement	☐	☐	☐	☐	☐
xvi.	Higher return on assets	☐	☐	☐	☐	☐
	<u>SOCIAL BENEFIT</u>					
xvii.	Improved corporate image	☐	☐	☐	☐	☐
xviii.	Improvement in sustainable innovation	☐	☐	☐	☐	☐
xix.	Increased levels of organisational commitment	☐	☐	☐	☐	☐
xx.	Employee autonomy	☐	☐	☐	☐	☐
xxi.	Performance improvement	☐	☐	☐	☐	☐
xxii.	Client satisfaction	☐	☐	☐	☐	☐
xxiii.	Enhanced organisational knowledge management	☐	☐	☐	☐	☐
xxiv.	Increased compliance with customers' expectations	☐	☐	☐	☐	☐

THANK YOU VERY MUCH

