

**SOCIO-ECONOMIC RELEVANCE OF LEAN AND GREEN CONCEPTS
IN ATTAINING SUSTAINABLE INFRASTRUCTURAL DEVELOPMENT**

EZENDUKA, CHIDIOGO JUDITH

(12CB014111)

SEPTEMBER, 2021

**SOCIO-ECONOMIC RELEVANCE OF LEAN AND GREEN CONCEPTS
IN ATTAINING SUSTAINABLE INFRASTRUCTURAL DEVELOPMENT**

BY

EZENDUKA, CHIDIOGO JUDITH

(12CB014111)

B.Sc Building Technology, Covenant University, Ota Ogun State.

**A DISSERTATION SUBMITTED TO THE SUBMITTED TO THE SCHOOL
OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc)
DEGREE IN CONSTRUCTION MANAGEMENT IN THE DEPARTMENT
OF BUILDING TECHNOLOGY, COLLEGE OF SCIENCE AND
TECHNOLOGY, COVENANT UNIVERSITY.**

SEPTEMBER, 2021

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirements for the award of the Degree of Master of Sciences in Construction Management in the Department of Building Technology, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria.

Mr. John A. Philip

(Secretary, School of Postgraduate Studies)

Signature and Date

Prof. Akan B. Williams

(Dean, School of Postgraduate Studies)

Signature and Date

DECLARATION

I, **EZENDUKA, CHIDIOGO JUDITH (12CB014111)** declare that this research was carried out by me under the supervision of Dr. Lekan, Amusan of the Department of Building Technology, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria. I attest that the dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of scholarly information used were duly acknowledged.

EZENDUKA, CHIDIOGO JUDITH

Signature and Date

CERTIFICATION

We certify that this study titled “**SOCIO-ECONOMIC RELEVANCE OF LEAN AND GREEN CONCEPTS IN ATTAINING SUSTAINABLE INFRASTRUCTURAL DEVELOPMENT**” was carried out by **EZENDUKA CHIDIOGO JUDITH (12CB014111)** of the Department of Building Technology, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria under the supervision of Dr. Lekan, Amusan and it is adequate in scope and quality for the partial fulfilment of the requirement for the award of the Masters of Science Degree in Construction Management.

Dr. Lekan Amusan

(Supervisor)

Signature and Date

Prof. Olabosipo I. Fagbenle

(Head of Department)

Signature and Date

Dr. A. B. Wahab

(External Examiner)

Signature and Date

Prof. Akan B. Williams

(Dean, School of Postgraduate Studies)

Signature and Date

DEDICATION

With gratitude and great joy in my heart, I dedicate my Masters dissertation to God Almighty who has made everything possible for me to pursue the programme to a successful cause. Also, to my wonderful parents, Mr & Mrs. Ezenduka who have supported me beyond imagination, and to my supervisor for his guide, my siblings, colleagues and awesome friends.

ACKNOWLEDGEMENTS

I thank God Almighty, for sustenance, provisions and wisdom and great ideas throughout the period of this research. My sincere acknowledgement goes to Covenant University for giving me an opportunity at her citadel to fulfil a desire to acquire my master's degree in Construction management.

My profound gratitude goes to the Project supervisor; Dr Lekan Amusan, who impacted me with morale, knowledge, guidance and support throughout the course of this project. The Head of Department; Prof, O. I. Fagbenle, for his steadfast support. In addition, the faculty and staff of the Department of Building Technology, Prof T.O. Mosaku, Dr Afolabi Adedeji, Dr. A. O. Ogunde, Dr. Mrs P. Tunji-Olayeni, Dr. J. Opeyemi, Dr. I. G. Omuh, and Dr. R. A Ojelabi for their tireless effort in enabling me to successfully go through the course work, assignments, term papers and examinations. I sincerely appreciate all their patience, hard work and commitment all for my success.

Furthermore, I owe appreciation to my parents Mr & Mrs. Ezenduka, for their facilitation, emotional, spiritual and financial support. Their benevolence contributed to my success on this cause.

Finally, my sincere appreciation goes to dearest friends, especially those who supported me in impactful ways, Ezenduka Chioma, Mr. Ekine Suoton and the respondents, great appreciation to you all.

Thank you and God bless you.

TABLE OF CONTENTS

CONTENT	PAGE
COVER PAGE	
TITLE PAGE	
ACCEPTANCE.....	i
DECLARATION.....	ii
CERTIFICATION.....	iii
DEDICATION.....	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xiii
ABSTRACT.....	xiv
CHAPTER ONE	1
1.0 INTRODUCTION	1
1.1 BACKGROUND TO THE STUDY	1
1.2 STATEMENT OF THE RESEARCH PROBLEM	6
1.3 RESEARCH QUESTIONS.....	8
1.4 AIM OF THE STUDY.....	9
1.5 OBJECTIVES OF THE STUDY	9
1.6 HYPOTHESES OF THE STUDY	10
1.6.1 Hypothesis 1.....	10
1.7 SIGNIFICANCE OF THE STUDY.....	10
1.8 SCOPE OF THE STUDY	11
1.9 DEFINITION OF KEY TERMS.....	13
CHAPTER TWO	16
2.0 LITERATURE REVIEW	16
2.1 INTRODUCTION.....	16
2.2 CONCEPTUAL FRAMEWORK	16
2.2.1 Concept of Construction Industry	16
2.2.2 Relevance of Construction to Nigerian Economy	17

2.2.3	Concept of Lean	19
2.2.4	Lean Construction	20
2.3	GREEN CONCEPT	21
2.3.1	Sustainability for lean and green in manufacturing	22
2.3.2	Awareness Level of Lean and Green Concept Application among Building Construction Professionals	24
2.3.3	Areas of Application of Lean and Green Concept in Attaining Sustainable Infrastructure	27
2.3.4	Lean and Green Concept Adoption Success Variables for Achieving Sustainable Development.....	37
2.3.5	Barriers towards implementing lean and green concept in the Nigeria building Construction industry.	44
2.3.6	Critical success factors underlining effective lean and green concept application.	48
2.3.7	Socio-economic Relevance of Lean and Green Concepts Adoption in the Construction Industry	51
2.4	SUSTAINABLE DEVELOPMENT GOALS.....	67
2.4.1	The Link between Building, Construction Industry and Sustainable Development Goals (SDGS)	68
2.4.2	GOAL 9: Industry, Innovation and Infrastructure – Build Resilient Infrastructure, Promote Sustainable development and Foster Innovation	72
2.4.3	Overview of the Papers Regarding Integration of the SDG’S	72
2.4.4	Sustainable Infrastructure Link with Cost, Quality and Labour	74
2.5	SOCIO-ECONOMIC VALUE OF LEAN AND GREEN CONCEPTS	78
2.5.1	Lean Manufacturing and Economic Sustainability	78
2.5.2	Lean Manufacturing and Environmental Sustainability	78
2.5.3	Lean Manufacturing and Social Sustainability	79
2.5.4	Green Manufacturing, Economic, Environmental and Social Sustainability	80
2.5.5	The Linkages between Lean and Green Concepts and their Application to Sustainable Building Construction	81
2.6	THEORETICAL FRAMEWORK	84
2.6.1	Theory of Lean.....	84
2.6.2	Theory of Sustainable Development.....	85
2.6.3	Review of Empirical Studies	87
2.7	REVIEW OF EMPIRICAL STUDIES	94

2.8	SUMMARY OF LITERATURE REVIEWED.....	101
2.8.1	Theory of Sustainable Development.....	101
CHAPTER THREE.....		104
3.0	RESEARCH METHODOLOGY.....	104
3.1	INTRODUCTION.....	104
3.2	DESIGN OF STUDY.....	104
3.3	STUDY AREA.....	105
3.4	POPULATION OF STUDY	106
3.5	SAMPLE AND SAMPLING TECHNIQUE	106
3.6	INSTRUMENT FOR DATA COLLECTION	107
3.7	VALIDATION OF INSTRUMENT	108
3.8	RELIABILITY OF THE INSTRUMENT	108
3.9	METHOD OF DATA COLLECTION	109
3.10	METHOD OF DATA ANALYSIS.....	109
CHAPTER FOUR.....		111
4.0	RESULTS	111
4.1	INTRODUCTION.....	111
4.2	RESEARCH QUESTION 1: WHAT IS THE AWARENESS LEVEL OF LEAN AND GREEN CONCEPT APPLICATION AMONG BUILDING CONSTRUCTION PROFESSIONALS?.....	111
4.3	RESEARCH QUESTION 2: WHAT ARE THE AREAS OF APPLICATION OF LEAN AND GREEN CONCEPT IN ATTAINING SUSTAINABLE INFRASTRUCTURE? 112	
4.4	RESEARCH QUESTION 3: HOW CAN LEAN AND GREEN CONCEPT ADOPTION SUCCESS VARIABLES HELP IN ACHIEVING SUSTAINABLE DEVELOPMENT?.....	114
4.5	RESEARCH QUESTION 4: WHAT ARE THE BARRIERS TOWARDS IMPLEMENTING LEAN AND GREEN CONCEPT IN NIGERIA BUILDING CONSTRUCTION INDUSTRY?.....	116
4.6	RESEARCH QUESTION 5: WHAT ARE THE CRITICAL SUCCESS FACTORS UNDERLINING EFFECTIVE LEAN AND GREEN CONCEPT APPLICATION?	117
4.7	RESEARCH QUESTION 6: WHAT IS THE SOCIO-ECONOMIC RELEVANCE OF LEAN AND GREEN CONCEPTS ADOPTION IN THE CONSTRUCTION INDUSTRY? 119	
4.8	TEST OF HYPOTHESIS.....	122

4.8.1	Hypothesis 1: There is no agreement of opinion by the respondents on the application of lean and green concepts.....	122
4.8.2	Hypothesis 2: Lean and green concept has no socio-economic relevance in the provision of infrastructural facilities	123
CHAPTER FIVE	126
5.0	DISCUSSIONS.....	126
5.1	INTRODUCTION.....	126
5.2	AWARENESS OF LEAN AND GREEN CONCEPT APPLICATION AMONG BUILDING CONSTRUCTION PROFESSIONALS	126
5.3	AREAS OF APPLICATION OF LEAN AND GREEN CONCEPT IN ATTAINING SUSTAINABLE INFRASTRUCTURE	127
5.4	LEAN AND GREEN CONCEPT ADOPTION SUCCESS VARIABLES FOR ACHIEVING SUSTAINABLE DEVELOPMENT.....	128
5.5	BARRIERS TOWARDS IMPLEMENTING LEAN AND GREEN CONCEPT IN NIGERIA BUILDING CONSTRUCTION INDUSTRY	130
5.6	CRITICAL SUCCESS FACTORS UNDERLINING EFFECTIVE LEAN AND GREEN CONCEPT APPLICATION	131
5.7	SOCIO-ECONOMIC RELEVANCE OF LEAN AND GREEN CONCEPTS ADOPTION IN THE CONSTRUCTION INDUSTRY	132
5.7.1	Lean Concept relevance on Environment	132
5.7.2	Lean concept relevance on economy	133
5.7.3	Lean Concept relevance on Society	134
5.7.4	Green concept relevance on environment.....	135
5.7.5	Green Concept relevance on Economy.....	136
5.7.6	Green Concept relevance on Society	136
5.7.7	Hypothesis 1: There is no agreement of opinion by the respondents on the application of lean and green concepts.....	137
5.7.8	Hypothesis 2: Lean and green concept has no socio-economic relevance in the provision of infrastructural facilities	138
CHAPTER SIX	140
6.0	SUMMARY, CONCLUSION AND RECOMMENDATIONS.....	140
6.1	Summary of the Findings	140
6.2	Conclusion.....	141
6.3	Contribution to Knowledge.....	144
6.4	Recommendations	146

6.5	Areas of Further Research.....	147
REFERENCES	148
APPENDICES	165

LIST OF TABLES

Tables	Title of Tables	Page
2.1	Environmental Benefits of Adopting Lean Method of Production	52
4.1	Awareness of Lean and Green Concept Application	111
4.2	Areas of Application of Lean and Green Concept	112
4.3	Lean and Green Concept Adoption Success	114
4.4	Barriers towards Implementing Lean and Green Concept in Nigeria	116
4.5	Factors Underlining Effective Lean and Green Concept Application	117
4.6	Socio-Economic Relevance of Lean and Green Concepts Adoption	119
4.7	Chi-square Goodness of Fit Result Agreement of Opinions	122
4.8	Chi-square Goodness of Fit result onsocio-economic relevance	123

LIST OF FIGURES

Figures	Title of Figures	Page
1.1	Map of Rivers State, Nigeria	12
2.1	Lean Principles in Construction	30
2.2	Instances of Lean Devices	32
2.3	Green Structure Accomplishing Sustainable Development Goals.	70
2.4	Lean Production.	80

LIST OF ABBREVIATIONS

LP	:	Lean Production
SME	:	Small and Medium Enterprise
LC	:	Lean Construction
GC	:	Green Concept
GM	:	Green Manufacturing
LM	:	Lean Manufacturing
LD	:	Lean Development
SDG's	:	Sustainable Development Goals
JIT	:	Just-In-Time
TQM	:	Total Quality Management
LR	:	Lean Reasoning
TPM	:	Total Productive Maintenance
L & G	:	Lean and Green
HR	:	Human Resource
SC	:	Safety Case
CP	:	Cost Proposal
SD	:	Sustainable Development
UN	:	United Nations
UK	:	United Kingdom
GBCA	:	General Building Contractors Association
LEED	:	Leadership in Energy and Environmental Design
GIVSM	:	Green Integrated Value Stream Mapping
WGBC	:	World Green Building Council
GHG	:	Greenhouse Gas
WBCSD	:	World Business Council for Sustainable Development
STD	:	Standard Deviation

ABSTRACT

The relevance of construction industries in any society cannot be ignored because it can bring about environmental, economic and social benefit and give building new designs. Construction industries also deal with waste management and has made recycling of waste a better thing in a society to give the environment a good image. This study sought to investigate socio-economic relevance of lean and green concepts in attaining sustainable infrastructural development in Rivers State. Descriptive and ex-post facto research designs were adopted for this study. The target population was two hundred and thirty (230) companies (small, medium and large-scale industries). The sample size was one hundred and forty-four (144) small, medium and large-scale construction companies in the study area. Purposive sampling technique was adopted for this study. The instrument for data collection was a questionnaire and was face validated by the experts with knowledge of the study. Cronbach Alpha reliability was used to test the reliability of the instrument and 0.999 was obtained. The data obtained were analysed using frequency, mean and standard deviation while the hypotheses were tested using Chi-square statistic. The findings revealed that: the respondents are aware of Lean and Green concept application among building construction professionals; global market competition, waste reduction, pollution prevention are some of the areas of application of Lean and Green concept in attaining sustainable infrastructure; top management involvement, effective leadership, skill and expertise are some of the Lean and Green concept adoption success variables for achieving sustainable development; poor work culture among project partners, lack of good policies, lack of demand from clients, cost of investment, are some of the barriers towards implementing Lean and Green concept in Nigeria Building Construction Industry; good work culture among project partners, good working policies, incentives, construction of adequate awareness are some of the critical success factors that underlines effective Lean and Green concept application; the socio-economic relevance of lean and green concepts on the environment, economy and society include: lowering of wastes, selling more and grow the business on a much smaller base of assets, creates value for customers by maximizing productivity, reduction of solid waste, reduces costs and increase value and improves the quality of life among others. The hypotheses results revealed that: there is a statistical significant agreement among the respondents on the application of lean and green concepts in attaining sustainable infrastructure, and that there is a statistical significant relevance of Lean and Green concepts on socio-economic relevance in the provision of infrastructural facilities. Recommendation was made among others that with respect to the findings of this study that: construction companies/industries involve in building and those into waste management should keep on training and retraining her staff about the Lean and Green concept application in the construction industry. Construction companies/industries should keep on applying Lean and Green concepts in different areas that will benefits them and the society.

Keywords: Socio-economic, Lean and Green Concepts, Sustainable Infrastructural Development.