LEAN PRODUCTION AND OPERATIONAL PERFORMANCE OF LARGE AND MEDIUM SIZED CONSTRUCTION FIRMS IN NAIROBI, KENYA

BY

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DECLARATION

This research project is my authentic work which previously has not been submitted to any university for examination.

Signed …… Date …….

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This research project has my approval for examination as the University supervisor.

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DEDICATION

This research report is dedicated to my husband for his unwavering moral, financial and emotional support throughout the study period.

ACKNOWLEDGMENT

I sincerely appreciate Professor James Njihia for the support provided during supervision of this research project, providing prompt feedback and valuable input that made a confident researcher in this study. In addition, am grateful for the academic support provided by Professor Wainaina Githii this project moderator together with all other academic staffs involved. Lastly, special appreciation to all the large and medium sized construction firms who positively responded to this study's survey.

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ABBREVIATIONS AND ACRONYMS

JIT Just In Time Systems

KERRA Kenya Rural Roads Authority

LP Lean Production

LPS Last Planner System

NCA National Construction Authorities

OP Operational Performance

PDCA Plan Do Check Act

PPC Percentage Planned Complete

RBT Resource Based Theory

TOC Theory of Constraints

TPS Toyota Production System

TQM Total Quality Management

VSM Value Stream Mapping

ABSTRACT

Lean production is a business oriented philosophy that enable firms both in manufacturing and service sector to focus on elimination of waste and/ or any non- value adding activity from their production systems resulting to value delivery to their customers. In spite of mixed reactions on the impact of lean production practices and operational performance from empirical studies, lean production continues to generate considerable global interest due to the benefits firms implementing its practices continues to enjoy. This study focused on evaluating widely applied lean production practices in the Kenyan construction sector and their impact on operational performance of these large and medium sized firms. Survey was made through physically and electronically delivered questionnaires. A response of 71 respondents was successful. According to the study, most of the respondents noted that quality management tools were moderately implemented, while last planner system was least implemented by the firms. A weak positive relationship was found to exist between operational performance and lean production practices, which was obtained through multiple regression analysis. This study recommends large and medium sized construction firms to implement a holistic lean system due to the synergy benefits attained rather than implementing an individual lean practice. However, considerable concern should be established on the lean practices being integrated. The study further recommends higher extent of the long term lean strategy implemented, as well as lean knowledge dissemination amongst firm employees in order to maximize the benefits of lean production.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Lean production is a relatively new paradigm that is positively transforming the business world. Due to this transformation, competitive construction firms are adopting it as a management approach best to their value delivery. Chiarini (2014) stated that lean production also referred to Toyota Production System (TPS) originated in Japan.

According to Shah and Ward (2007), significant growth in Lean tools in the recent years has been due to their focus on waste elimination and maximizing the value of the end product which is delivered to the customers. This paper seeks to explore how integrated approach of lean production practices influences the firm's performance.

According to NCA (2011), Kenyan economy has experienced gradual growth in the construction sector, contributing to the country's increasing growth and Nairobi being a regional hub for investors. This has also been accelerated by government support of the industry with construction of affordable housing by 2022 being part of its current Big agendas which are also embedded on vision 2030, which acknowledges that construction sector is a key enabler of the government being globally competitive by providing better quality of life through housing and improved housing infrastructures. In pursuit of value delivery in a competitive market while reducing costs, firms are exploring approaches suitable for their efficiency and effectiveness. This has resulted to implementation of lean production by companies to enhance their productivity.

1.1.1 Lean Production

According to Shah and Ward (2007) lean production is an integrated socio- technical system aiming at waste eliminate through reduction of suppliers, customers and internal variables. Yang, Hong and Modi (2011) argued that lean production refer to practices which focus on reduction of both waste and non- value added activities from a firm's production operations.

According to Calantone, Cavusgil and Zhao (2002) successful implementation of lean production is modeled on full commitment of all team members based on their capabilities, hence, team's creativity and continuous learning is paramount. This enables lean producers to understand their customers' needs and design products that satisfy their requirements. Every business aims among other objectives at customer satisfaction, business growth, competitiveness, survival and being more productive thus improved profits. Due to its ability to enhance firm's productiveness, this has yielded lean production's interest globally.

Calantone et al.(2002) further argued that the major tools of operation that have fostered successful implementation of lean production include; customer satisfaction through identification of value adding activities, automation of processes with respect to people operating the processes, teamwork which ensure synergy from all team members is maximized and continuous improvement. These tools are mainly supported by integrated lean production techniques which deliver a win- win approach to all the stakeholders need for satisfaction.

According to Shah and Ward (2003), Jacob et al. (2009) and deTreville and Antonakis (2006), lean production tools include; Just In Time, Kanban, Total Productive Maintenance, Value stream Mapping, Poka Yoke, The 5S and Production Smoothing. In addition, Zhang and Chen(2016), Aziz and Hafez (2013) and Salem, Solomon, Genaidy and Luegring (2005) argues that the most effective lean production tools in construction industry are; last planner system, daily huddle meetings, first-run studies, increased visualization, Concurrent Engineering, Kanban, Value stream mapping, and Quality management tools.

1.1.2. Operational Performance

Performance is the ability of a firm to operate in an efficient and profitable way resulting to its competitiveness, growth and ability to positively respond to threats and opportunities within its environment. The performance of a firm is measured by its ability to utilize resources within its reach in an efficient manner towards its objectives achievement. A firm's growth is evidenced in its good performance through objectives achievement; hence firms should incorporate the right growth strategy (s) for better performance. Calantone, Cavusgil and Zhao (2002) argues that firm performance is highly affected by the firm's innovativeness and its learning orientation which enables utilization of different strategies in forecasting environmental and market changes while making appropriate adjustments, this in return influences the operational performance of the firm.

1.1.3. Construction Firms in Nairobi Kenya

According to NCA (2011) the construction sector in Kenya comprises of developers and contractors who significantly influence the economic growth of the country and improves Kenyans quality of life by providing infrastructures like roads, schools and building required for production of goods and services in the country. Developers are classified into building works, road works and water works. According to Kenya Rural Roads Authority (KERRA), road works in Kenya is classified into five classes mainly A, B, C, D and E which are distinguished by administrative centers served by the road; besides these roads, others are classified as special roads.

The NCA (2011) defines a contractor as a person who carries on contract business of construction, installation or erection for another person any structure that is above the ground or any other related work like supply of necessary materials and/or labor for work. According to NCA (2011), a total of 18,551 contractors have been registered country wide. These registered contractor firms are classified into different categories outlining the amount of work done and the firm's specialization in construction industry mainly; electrical engineering services, road works, building works, water work and mechanical engineering services. Kangai (2015) noted that more than 50% of the registered contractors are Kenyan with a few of the registered firms being foreign contractors especially in NCA 1 category whereby contractors undertake work of unlimited value.

According to NCA (2011), the NCA is the regulatory body charged with statutory responsibility of monitoring performance of construction firms in Kenya, ensuring that outlined key performance indicator for stakeholders in the sector are adhered to. NCA (2011) affirmed that the construction industry is concerned with construction, extension, installation, repair, maintenance, renewal, removal, renovation, alteration, dismantling, or demolition of a building whether constructed wholly or partially above the ground level, any road/airway/harbor work, drainage/river works, mechanical/telecommunication work and any bridge/pipeline or earthwork.

According to Economic Survey (2017) the sector has been experiencing an improving period fostered by stable government commitment to invest in the industry especially railway and road industry, provision of financial support by banks and financial institutions, efficient operations by the regulatory agency and utilization of innovative construction technologies like expanded polystyrene panels that foster faster and cost saving housing. Despite the industry's contribution to the national economy, construction sector experienced slowdown in its growth due to challenges like; low rate of employee compensation thus reduced investment in housing, Kenyan currency instability against international currencies, budget overrun and delayed project completion from the projected time. In view of the pivotal role played by construction firms to the country's development, it's paramount that construction companies focusing on competitive performance employ lean production practices in order to attain efficiency.

Research on lean production in the construction industry in Nairobi has been understudied; hence the author aims to enhance production in the construction industry in Nairobi through the insights provided in this study and subsequent studies to be made by other scholars.

1.2 Problem Statement

Lean production is a vital management strategy which not only enhances productivity, it also eliminates defects, reduce costs, smooth the production process and promote faster delivery**.** Shah and Ward (2003) assert that lean production tools are highly related hence, lean production is more effective when implemented as an integrated system due to the synergy obtained from total performance of the implemented practices which exceeds the sum performance from individual lean practice.

Study by Crute,Ward, Brown and Graves (2003) on implementing lean in aero scope industry noted that lean production will change everything in almost every industry especially when effectively implemented in any firm that adopts autonomous working and learning from experience continuously gained. As well, Yang et al. (2011) found that LP is positively related to business performance of a firm. In addition, Fullerton and Wempe (2009), noted that lean production positively influences the profitability of a firm.

Study by Hoonakkera, Carayona and Loushinec (2010) argue that contractors who implement total quality management approach in their construction firms experience better relationships with contracting partners like architects and reduced reworks thus improved performance and higher levels of customer satisfaction. This resulted to more loyal customers despite quality in the industry being challenging due to the nature of construction products and multiple parties involved.

In his study on the contribution of the principles of lean construction to meet challenges of sustainable development in Nigerian, Oladiran (2008) noted that though lean practices are in practice in the construction sector in Nigeria, more awareness and knowledge on these principles' should be disseminated to the firm employees. Cavusgil and Zhao. (2002), assert that high performing firms have higher levels of learning orientation which enables the employees to foresee market changes and adjust accordingly. Hussin, Rahman and Memon (2013) study, on the way forward toward sustainable construction, noted that lean implementation is the key driver of achieving sustainable and green construction that will handle traditional construction problems of cost &time overrun, pollution and top management support amongst others. Weru (2015) argue that for firms to experience complete operational efficiency, they should implement lean practices, despite the challenge encountered in the implementation. Walukwe (2016) in his study on lean practices and operational performance of automotive firm's workshops in Nairobi noted that lean practices are implemented in the automotive industry since they are positively related to the performance of firms.

A study by Openda (2013) on performance of firms listed with Nairobi Securities Exchange noted existence of positive relationship between lean practices and prediction of the firm performance. In addition, Owiny (2016) studying the impact of lean manufacturing practices and operational performance of beer brewing process noted that the steady operational performance of Kenya Breweries Ltd is influenced by the implemented lean practices which have positively impacted the firm's performance.

This study is therefore motivated by inadequate research work on lean production practices focusing on construction firms compared to the manufacturing sector. Will lean production influence the performance of firms in the construction industry in Nairobi?

1.3. Research Objectives

1.3.1. General Objective

The main objective of this research study is to evaluate the application and impact of lean production on operational performance of construction firms in Nairobi, Kenya.

1.3.2 Specific Objectives

i. To determine lean production practices implemented by construction firms in Nairobi;
ii. To establish the relationship between lean production practices and the operational performance of construction firms in Nairobi;
iii. To evaluate the benefits of implementing lean production among construction firms in Nairobi;
iv. To determine the challenges encountered in the implementation of lean production.

1.4 Value of the Study

This study is anticipated to be of value to the construction firms in enabling them understand the vital role of implementing lean production practices in enhancing efficiency of their operational performance.

The study is expected to enrich the increasingly growing body of scholarly articles on lean production. It's anticipated to be of great help to researchers' studying lean production practices by providing more insights to their study work based on the findings of this work. This research paper aims at providing informative information to the NCA as the government agency implementing policy and regulating construction in Kenya. It's anticipated that this project will provide insights on how the industry can be enhanced through implementation of effective lean practices.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents the contextual and theoretical literature regarding lean practices and their influence on operational performance obtained from critical point of knowledge and from existing research studies.

2.2 Theoretical Background

This research study will be underpinned on theory of constraints, contingency and resource based theories.

2.2.1 Contingency Theory

According to Fullerton, Kennedy and Widener (2004), this theory has no best way that fits a firm, hence, the firm should adapt their structure to fit their changing environment by identifying their right contextual factor that enable them attain high performance. Considerable interest continues to rise in the manufacturing sector and among lean practitioners on contingency theory due to its ability to foster continuous development of the firm. In addition, Sousa and Voss (2008) noted that this approach shows the link between best practices and improved performance.

2.2.2 Resource Based Theory (RBT)

This theory suggests that a firm comprise of different types of resources and the fewer the resources; the less competitive is the firm. According to Grant (2001) RBT, is based on

resources and capabilities which provide long term strategy of a firm, hence influencing its profits. Krasnikov and Jayachandran (2008) illustrates that competitiveness of a firm is highly influenced by resources which differ in value and sustainability and these resources are embedded on the firm's functions. Resources are production inputs like capital equipments, finances, skills of the workforce, patent rights, and brand name while capabilities is what the firm do from the synergy of its available resources.

Competitive lean production firms use their resources in a cost effective manner, thus enhancing continuous improvement of the firm operations and sustainable development.

2.2.3 Theory of Constraints (TOC)

This is a system management theory focusing on the interdependent links within an organization which coordinate to deliver the overall objectives of the firm. According to Nave (2002) TOC enable managers to effectively focus on capability of the firm's constraints in order to improve the operational performance of the firms since the strength of the weak link/ constraint influences the performance of the firm. Successful implementation of TOC five steps in handling the firm's constraint improves the firms throughput. A study by Vore (2002) noted that when TOC is effectively adopted, a firm benefits from increased profits, reduced inventory and better capacity.

2.3 Lean Production Practices in Construction Industry

In the recent years, the techniques of lean productions have been used by almost every sector of manufacturing and service industries. With increased construction competition, contractors are opting for lean promise of eliminating waste and improving a firm's

performance. According to Sacks, Koskela, Dave and Owen (2009) most of lean production tools applied by TPS are applicable in construction industry, however, some lean construction practices aren't applicable in lean manufacturing. This paper seeks to evaluate implementation of some lean production techniques in the construction sector.

2.3.1 Last Planner System (LPS)

According to Aziz and Haref (2013) LPS is a lean technique in construction projects effective for managing the relationships and communications which are required for programs coordination, production planning, project delivery between the foreman and the site management, hence ensuring issues are handled before they become critical.

Study by Fernandez-Solis, Porwal,Lavy, Shafaat, Rybkowski,Son and Lagoo (2012) and Salemi et al (2005) argued that LPS is an operating technique designed to maximize work flow, address project variability and promote rapid learning in construction. The last planner is the person or group of people responsible to complete a specified task, who are guided by look-ahead schedule which helps in pulling scheduled team activities, resulting in optimizing firm resource.

Successful operation of last planner system is based on its work flow control and production units achieved through its look-ahead schedule and weekly report planning respectively. The system communicate the work which *should* be done as planned, work that *can* be achieved within specified limitations and work that *will* be accomplished when the constraints specified are well considered.

Study by Shang and Pheng (2014) argued that satisfactory work is enhanced by last planner features which include percentage plan complete (PPC) which allows forecasting of work to be reliable, thus planned tasks are completed within the scheduled time and identify why tasks are not completed as planned with recommendations made being implemented.

2.3.2. Just In Time System (J.I.T)

J.I.T is a Management approach which ensures that a firm only produces the necessary quality and quantity product at the right time they are needed and availed at the right place they are required. According to Salem et al (2006) J.IT system ensures required units are only availed when required, hence avoiding inventory storage as it creates waste. This system hence enables reduction of costs associated with storage and enhances strong relationship between the contractor and subcontractors.

This approach creates a pull system which requires high quality levels to be produced at each stage and strong vendor relationships being maintained. When effectively implemented, J.I.T enable firms to achieve lean objective of waste elimination is achieved through, Shah and Ward (2007) simplification of manufacturing processes where excess inventories and large lot sizes are eliminated, otherwise when not managed lengthens customer cycle times.

2.3.3. Quality Management Tools

A study by Zhang and Chen (2016) noted that these tools include Total Quality Management (TQM) and Plan- Do- Check- Act (PDCA) which respectively focus on quality and performance improvement as well as continuous improvement of the construction project. In addition, these tools facilitate delivery of the right quality from the commencement of the construction project, since it is challenging to conform to a particular quality in construction. Study by Hoonakkera, Carayona and Loushinec (2010) utilization of TQM in construction increased both the operational performance and levels of customer satisfaction hence more loyal customer.

2.3.4 Value Stream Mapping (VSM)

Rother and Shook (2003) argued that VSM is a collection of all the actions necessary to bring a product in all the productions flows from order placement by the customer to product delivery. In addition, Alves, Tommelein and Ballard (2005) assert that VSM reveals flow of information and materials, the cycle time for each operation and lead time for each process thus a vital tool for unveiling waste and providing opportunity for system improvement. Study by Salem, Solomon, Minkarah and Genaidy (2006) argued that due to mobile workstations common in construction industry, increased visualization helps identify workflow, create awareness of action plans for each job at the site, thus revealing hidden problems in the flow and enabling value stream practitioner to understand the end product as perceived by the customer.

2.4 Performance Measurement

The most measurable aspect of a firm is its performance. According to Van der Stede, Chow and Lin (2006) firms that utilizing diverse performance measurement systems including objective and subjective financial measures achieve higher performance reflected on the long term performance of the firm. A study by Ataalah, Khalid, Musli, Ahmad and Aref (2016) noted that Operational performance of a firm is measured by; work in process inventory, project completion time and project cost.

Zimina, Ballard and Pasquire (2012) noted that, a well planned construction project enhance reduction of construction cost by ensuring that the contractors operate within the targeted cost established when determining the target product value and share any additional pain or gain that arises. In addition, Hussin, Rahman and Memon (2013) noted that lean implementation is the key driver of achieving sustainable construction that will handle traditional construction problems of cost &time overrun, pollution and top management support amongst others.

2.5 Lean Production and Operational Performance

The influence of lean production on performance of firms has continuously gained considerable attention among researchers, while its benefits have resulted to increased implementation by firms. Shah and Ward (2003) emphasize that implementation of lean production practices as a bundle rather than individually greatly influence the performance of a firm due to synergy effect of the combined lean production practices. A study by Calantonea et al. (2002) found that firms achieving high level of performance

are influenced by implementation of learning orientation that enable them to foresee market changes and adjust accordingly. Salem et al (2006) noted that implementing J.I.T system enhance cost reductions since only necessary stock of material is handled and delivered when required thus eliminating costs related with inventory storage.

According to Locatelli, Mancini, Gastaldo and Mazza (2013) effective implementation of last planner systems fosters major efforts on planning of work, establishment of focused assignment control and commitment to the project delivery, thus resulting in reduction of waiting time and timely construction project completion. In addition, Salem et al. (2006) noted that this system improves work flow thus reducing variability likely to cause delay in project completion time.

Aziz and Hafez (2013) noted that firms implementing last planner system due to the combined benefits of weekly meetings and percentage plan complete not only enjoy stress free production planning & control but also complete their projects within the set time and budget.

2.6 Benefits of Lean Production Implementation

As a philosophy, lean aims at elimination of non-value add activities in all processes of the firm, resulting to process development which has significantly improved business performance due to better operation and transforming the firm. According to Zhang and Chen (2016), implementation of lean tools is positively related to knowledge creation which should consistently be improved as it increases innovation of construction.

According to Salem et al (2005) the last planner system enables construction contractors to be more realistic when assigning tasks to the workforce.

Studies conducted by Aziz and Hafez (2013) and Locatelli et al (2013), noted that implementation of lean tools on construction projects greatly reduced project completion time due to variability reductions and enhance smooth work flow thus improving productivity.

2.7 Challenges Facing Implementation of Lean Production

According to Achanga, Shehab, Roy and Nelder (2006),Aziz and Hafez (2013) and Porwal et al. (2010) Lack of senior management leadership on management of construction projects not only causes delays in project delivery time, but also leads to increased project cost thus affecting the returns of the construction firm. In addition, lack of top management commitment and a sustainable culture of implementing lean tools affects the success of any lean tool implemented. Study by Shah and Wards (2003) noted that adoption of lean production is challenging since holistic adoption of an entire lean system is more effective rather than an individual lean production tool. To enhance its success, a firm has to establish long term sustainability mechanism which reviews lean tools implementation.

According to Porwalet al. (2010) and Zhang and Chen (2016) inadequate knowledge on implemented lean tools in a firm hider their maximum efficiency. The employees should also undergo training on the lean tools implemented by the firms so as to maximize the

potential of each tool during its implementation. Salemi et al. (2005) noted that training is vital and should be conducted for lean tools to be effectively used.

2.8 Conceptual Framework

The graph below is a representation of the independent and dependent variables of lean practices and their impact on operational performance respectively.

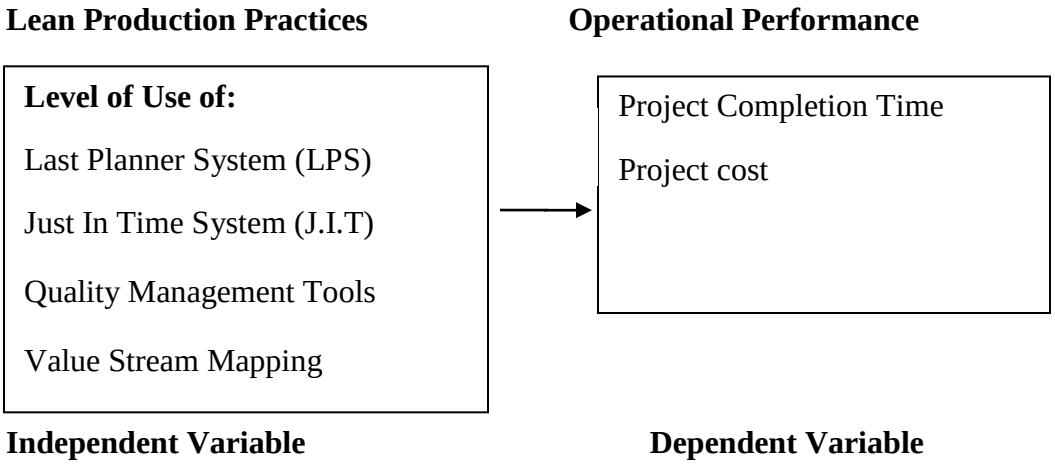

Figure 2.1: Conceptual Framework

Source Author (2018)

2.9 Hypotheses

H1: Lean production is positively associated with the operational performance of construction firms.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter elaborates how information and finding of this research proposal is obtained through the subsections below.

3.2 Research Design

According to Cooper and Schindler (2006) research design is a blue print used in data collection, measurement and analysis in a research work. The researcher conducts this research within a short period of the study time, hence, cross-sectional study approach is used to investigate the relationship between lean production and operational performance. Descriptive research was adopted as an appropriate design due to its ability to describe variables in a study, collect data, analyse data, and generate the hypothesis, thus allowing testing of the study's hypothesis. Survey is used by the researcher to obtain and describe necessary information that helps in making decision regarding the research objectives. In addition, multiple regressions established the relationship between the two variables.

3.3 Population

Study by Curwin and Slater (2002) affirm that population are all the items considered to be of interest to a study. The Kenyan Gazette (2015) has listed 239 large and medium sized contractor firms in Nairobi constituting 415 registered categories. These firms are categorized as NCA 1 and have been considered for this study due to their high probability of fully implementing lean production practices compared to other firms.

3.4 Sampling Design

According to Kothari (2002) argue that sampling design is an appropriate method which a researcher uses on a given study to select items to be observed. Since construction firms are classified into different categories and classes by national construction authority based on their specializations, this study employed stratified sampling to provide adequate data that was used to analyze the construction firms. A study by Bartlett**,** Kotrlik and Higgins (2001) found that the sample size of a population is influenced by the research data being continuous or categorical data in natures. Study by Powers and Xie (2008) argued that categorical data is measured using limited number of values while continuous variables have infinite number of values.

A target sample of **118** firms was used to represent the population. This sample size was obtained through this formula;

$no = Zpq \div e^2$

Where: Z= value obtained from normal distribution /statistical tables

P=Estimated proportion (estimated at .5)

q= (1-p) and e= Confidence interval at .05

no= Sample size for larger populations

For smaller populations: n= no/ 1+ [(no-1)/N]

n= Sample size for smaller populations and

N=Population

Table 3.1: NCA 1 Company Distribution

	Company Distribution	Frequency	Target Sample n/N
1	Building Works	156	44
2	Road Works	92	26
3	Water Works	53	15
4	Electrical Engineering	59	16
5	Mechanical Engineering	39	11
6	Electrical Works	11	3
7	Mechanical Works	3	1
8	Sewer Works	1	1
9	Civil Engineering	1	1
	Total	**415**	**118**

Source Author (2018)

3.5 Data collection

Primary data from the respondents who represent the study population will be obtained through the use of structured questionnaires. According to Cooper and Schindler (2006) questionnaire is an appropriate method of obtaining data as it enables the researcher to customize the questions thus gathering data regarding the study hypothesis and specified objectives. Structured questionnaires were administered and analyzed since they provide possible alternatives to the respondents, and ensure uniformity in measurement of variables.

The questionnaire has been divided into three sub sections which aim at gathering bio data from the respondents about the firm, the extent of lean production implementation and the impact of lean production on operational performance respectively. The respondents of these questionnaires are the project/ construction manager and/or operational managers from the different firm due to their knowledge and interaction with lean tools at the construction site.

3.6 Data Analysis

All received questionnaires are reviewed with the aim of checking errors and coding the data submitted. Descriptive statics approaches of mean, standard deviation and distribution tables analyzed data in the questionnaires, summarizing it to determine lean production practices implemented by construction firms in Nairobi. To affirm if lean practices influence the operational performance of firms, multiple regressions are used to analyze this data because it determines the potential of grouped independent variables to predict an identified dependent variable.

The Liner regression equation represented below will be used to test the hypothesis;

$C=\beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$

C= Cost

β_o = Constant factor

β_1- β_6= regression weights attached to the variables

X_1- X_4= J.I.T, VSM and QMT and LPS

ε = Error term

$T=\alpha_o + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \varepsilon$

T= Time

α_o = Constant factor

α_1-α_6= regression weights attached to the variables

X_1- X_4= J.I.T, VSM and QMT and LPS

ε = Error term

Table 3.3: Data Analysis Techniques

	Objective	Technique
1	Determination of LP Practices	Descriptive Statistics
2	Relationship between LP and OP	Regression Model
3	Benefits of LP Practices Implementation	Descriptive Statistics
4	Challenges of LP Practices Implementation	Descriptive Statistics

Source Author (2018)

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents analysis of data and discussions of research methodology, elaborating the findings of the study's objectives, the general objective being the impact of lean production on the performance of large and medium sized construction firms in Nairobi, Kenya.

A survey of 118 respondents was used in this study resulting in 71 completed and returned questionnaires representing 60% of the sample size. According to Mugenda and Mugenda, (2013) response rate above 50% is adequate while 70% is incredible. This study finding concludes that the response rate of 60% is reliable.

4.2 Descriptive Findings

4.2.1 Construction Firm Category

Table 4.1 Company Category

Company Category	Response Frequency	Percentage
Building Work	30	42.3
Road Works	12	16.9
Water Works	8	11.3
Electrical Engineering	9	12.7
Mechanical Engineering	5	7.0
Electrical Works	2	2.8
Mechanical Works	5	7.0
Total	**71**	**100**

Source Author (2018)

The findings of this study revealed that the response distribution met the study's expectations. It also found that there were multiple registrations of NCA firms in different categories. Respondents from civil engineering and sewer work were among the 47 unsuccessfully completed questionnaires which accounted for 40% of the survey.

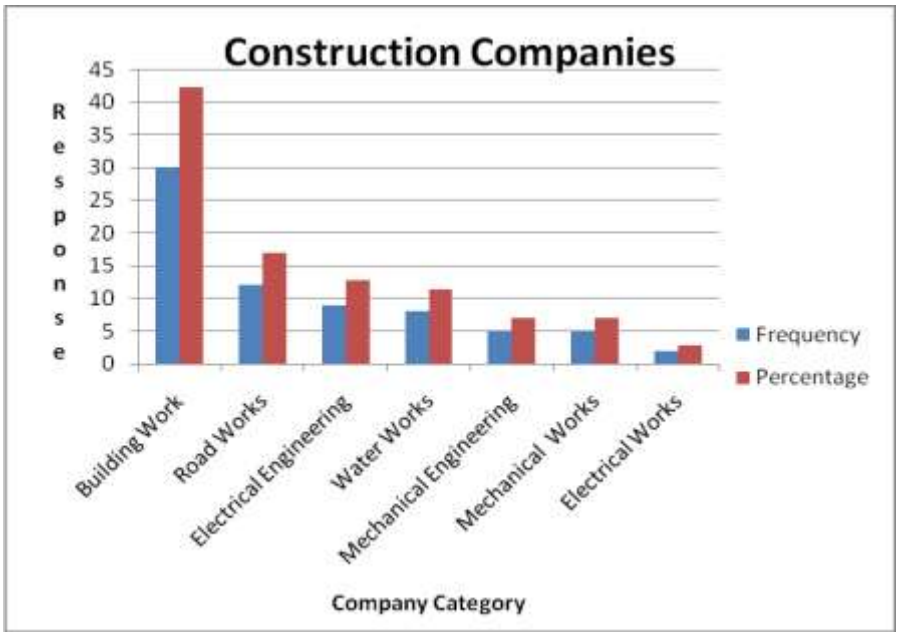

Figure 4.2: Company Category

4.2.2. Position Held in the Firm

Table 4.2 Respondent Job Title

Position Held	Frequency	Percentage
Project/ Construction Manager	42	59.2
Operations Manager.	22	31.0
Others	7	9.9
Total Mean	**71**	**100**

To a higher extent, project/construction managers were expected to respond to the study due to their conversance with lean production practices implemented at the firm's project. The findings established that Project/ construction managers widely responded to the study at 59.2%

4.2.3 Length of Service in the Firm

This findings revealed that majority of the respondent worked in the firm for a duration of 6-10 years representing 53.5% while those who worked for a period longer than 10 years represented 19.7%. Respondents whose service was below 5 years constituted 26.8%. This findings revealed that the respondents understood the lean production practice that their respective firms had implemented and mostly provided reliable date.

4.2.4 Number of employees in the Firm

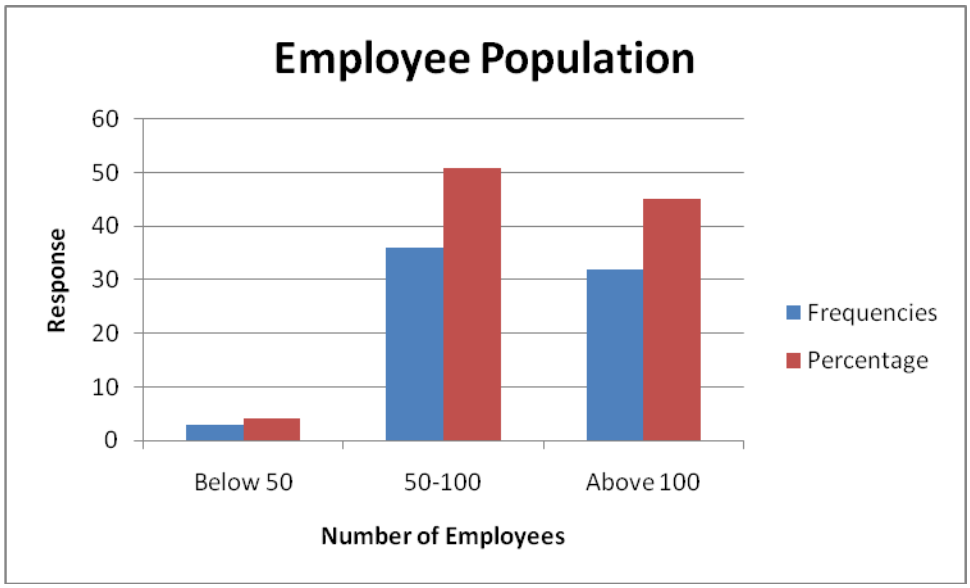

Figure 4.3 Company Size Graph

The study aimed at evaluating the number of employees in the surveyed firms so as to identify if the firm qualifies to be large or medium sized firms.

4.2.5 Education Level

Evaluation of education level aimed at assessing training needs by the firm based on the respondents' education background. Most of the respondents were bachelor degree

holders at 38%, graduates at 29.6%, diploma at 9.9% , doctorate at 8.5% each, while Others comprising of O-Level represented 14.1% of the respondents.

4.2.6 Construction Firm Ownership

Analysis of the data completed indicate that majority of the firms are owned by Kenyans at 56.3% while foreign owned firms represented 43.7%.

4.3 The Extent of Lean Production Implementation by Large and Medium Sized Construction Firms

Through the use of a Likert 5 scale, the researcher evaluated the extent to which firms implemented lean production tools, the benefits and challenges encountered in the implementation. The study concluded that all the surveyed firms acknowledged that employing some extent of lean production.

4.3.1 Last Planner System

Table 4.3 Last Planner System Implementation

Last Planner System	Mean	Standard Deviation
Weekly work flow is planned on look ahead schedule based on staff capability	3.46	0.502
The firm regularly reviews causes of completed and uncompleted tasks	3.19	0.400
The firm maintains strong relationships with its supply partners	3.56	0.527
Total Mean	**3.40**	**0.47**

The researcher sought to evaluate the extent to which the construction firms implemented lean production tools by ranking the extent of use against the Likert scale. The table

below represents the findings. At a standard deviation of 0.47 which is below 0.5, the study concluded that this lean tool is implemented at low extent by majority of the construction firms surveyed.

4.3.2 Just In Time (J.I.T) Systems

Table 4.4 Just In Time System Implementation

Just In Time System	Mean	Standard Deviation
The firm ensures right inventory is availed at the time required.	3.44	0.649
The firm maintains strong relationship with its supply partners.	3.535	0.651
The firm maintains minimum inventory.	3.563	0.527
Total Mean	**3.51**	**0.61**

Findings of this research found that J.I.T system is highly implemented by most of the firms as indicated by the standard deviation on table 4.5.

4.3.3 Value Stream Mapping

Table 4.5 Value Stream Mapping Implementation

Value Stream Mapping	Mean	Standard Deviation
The firm has efficient flow of information and material.	3.056	0.374
There is visualization of work on progress at each stage to reveal hidden problems in work flow.	2.606	0.547
Total Mean	**2.831**	**0.46**

The finding observed from the above table concluded that VSM is implemented at moderate extent by majority of the construction firms in Nairobi.

4.3.4 Quality Management Tools

Table 4.6 Quality Management Tools Implementation

QMT	Mean	Standard Deviation
The firm applies TQM principles (customer focus, people involvement and continuous improvement) to deliver quality construction projects.	3.901	0.74
The firm has strong PDCA findings to continuously improve project quality.	3.437	0.648
Total Mean	**3.67**	**0.69**

With a standard deviation of 0.69, Quality Management Tools are highly implemented by the surveyed firms.

Table 4.7 LP Descriptive Statistics

LP Implementation	Mean	Standard Deviation
Last Planner System		
Weekly work flow is planned on look ahead schedule based on staff capability	3.46	0.502
The firm regularly reviews causes of completed and uncompleted tasks	3.19	0.400
The firm maintains strong relationships with its supply partners	3.56	0.527
Just In Time Systems		
The firm ensures right inventory is availed at the time required.	3.44	0.649
The firm maintains strong relationship with its supply partners.	3.535	0.651
The firm maintains minimum inventory.	3.563	0.527
Value Stream Mapping		
The firm has efficient flow of information and material.	3.056	0.374
There is visualization of work on progress at each stage to reveal hidden problems in work flow.	2.606	0.547
Quality Management Tools		
The firm applies TQM principles (customer focus, people involvement and continuous improvement) to deliver quality construction projects.	3.901	0.74
The firm has strong PDCA findings to continuously improve project quality.	3.437	0.648

4.4 Benefits of Lean Production Implementation

This section sought to evaluate the extent to which the firm had benefited from implementation of lean tools.

Table 4.8 Benefits of Lean Implementation

Benefits of Lean Implementation	Mean	Standard Deviation
Improving customer satisfaction	4.099	0.8134
Realistic work assignments	3.887	0.7474
Reduced production cost	3.634	0.7219
Better flow of work	3.916	0.6491
Better knowledge creation	4.423	0.5772
Total Mean	**3.99**	**0.70**

This study found that that surveyed firms benefited from the implementation of lean production to a high extent.

4.5 Challenges encountered with Lean Production Implementation

Findings from data analysis ranked the challenges encountered as represented below.

Table 4.9 Challenges of Lean Implementation

Challenges of Lean Implementation	Mean	Standard Deviation
Lack of long term lean sustainability strategy	2.437	0.98
Unfamiliarity with lean tools applicable	2.986	0.96
Inadequate Resources	2.93	0.931
Inadequate Knowledge and training on LP	2.93	0.915
Lack of top management support/ leadership	3.87	0.608
Total Mean	**3.03**	**0.88**

The study established that the respondents strongly agreed that the challenges they faced in their respective firms influenced implementation of lean production practices.

4.6 Relationship Between LP Practices and OP of Construction Firms

A multiple regression for each indicator both cost and times were individually evaluated by the researcher to determine the relationship between lean production tools implemented and the firm's operational performance. Using the regression equations below for cost and time respectively, the researcher focused on lean strategies of; last planner system, just in time systems, value stream mapping and quality management tools. The linear regression equations below for project completion time and project cost were used:

$C=\beta_o + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$

$T=\alpha_o + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \varepsilon$

Where:

C and T= Cost and Time respectively

$x_{1=}$ Last Planner Systems

$x_{2=}$ Just In Time Systems

$x_{3=}$ Value Stream Mapping

$x_{4=}$ Quality Management Tools

ε = Error

4.6.1 Project Completion Time

Table 4.10 Project Completion Time Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.312[a]	.097	.084	.30447
2	.398[b]	.158	.134	.29639

a. Predictors: (Constant), QMT
b. Predictors: (Constant), QMT, JIT
c. Dependent Variable: Project Completion Time

The Coefficient of determination R Square used on this model summary concluded that the four predictors (independent variables) used influenced project completion time by 13.4%.

Table 4.11 Project Completion Time ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.689	1	.689	7.422	.008[b]
	Residual	6.409	69	.093		
	Total	7.099	70			
2	Regression	1.125	2	.562	6.402	.003[c]
	Residual	5.974	68	.088		
	Total	7.099	70			

a. Dependant Variable: Project Completion Time
b. Predictors: (Constant), QMT
c. Predictors: (Constant), QMT, JIT

ANOVA determined existence of a significance between project completion time and lean production tools used in the relationship. The study concluded that a significant relationship exist as the derived level of significance of 0.003[c] is less than 0.05.

Table 4.12 Project Completion Time Coefficients

Model		Unstandardized Coefficients		Standardized coefficient		
		B	Std. Error	Beta	t	sig
1.	(Constant)	2.587	.196	.312	13.178	.000
	QMT	.153	.056		2.724	.008
2.	(Constant)	3.078	.292		10.547	.000
	QMT	.166	.055	.338	3.021	.004
	JIT	-.150	.068	-.249	-2.226	.029

a. Dependant Variable: Project Completion Time

From the coefficient results on table 4.9.2, we derive the regression equation below for time indicator.

Project Completion Time = 3.078+ 0.166 QMT -0.15 JIT + ε

This study found that all other factors held at a constant of 3.078, an increase in a unit of quality management tools and a decrease in a unit of just in time system would improve the completion time of the project.

4.6.2. Project Cost

Table 4.13 Project Cost Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.333[a]	.111	.098	.472111
2.	.402 [b]	.161	.137	.46187
3.	.464 [c]	.215	.180	.45013

a. Predictors: (Constant), VSM
b. Predictors: (Constant), VSM, JIT,
c. Predictors: (Constant), VSM, JIT,LPS
d. Dependent Variable: Project Cost

Coefficient of determination R Square was used to indicate that the influence of all surveyed predictors. It noted that the project cost was influenced by 21.5% by value stream mapping and last planner systems.

Table 4.14 ANOVA- Project Completion Time

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.917	1	1.917	8.600	.005[b]
	Residual	15.379	69	.223		
	Total	17.296	70			
2	Regression	2.790	2	1.395	6.538	.003[c]
	Residual	14.506	68	.213		
	Total	17.296	70			
3	Regression	3.720	3	1.240	6.120	.001[d]
	Residual	13.576	37	.203		
	Total	17.296	70			

a. Dependant Variable: Project Cost
b. Predictors: (Constant), VSM
c. Predictors: (Constant), VSM,JIT
d. Predictors: (Constant), VSM,JIT, LPS

The findings of this study used ANOVA to determine existence of a significant relationship between dependent and independent variable used in the multiple linear regression. The study noted a significant relationship exist between some lean production tools and project completion time. A significance level of 0.11 was derived.

Table 4.15 Coefficients of Results of Project Time

Model		Unstandardized Coefficients		Standardized coefficient		
		B	Std. Error	Beta	T	sig
1.	(Constant)	3.633	.274		13.236	.000
	VSM	-.302	.103	-.333	-2.933	.005
2.	(Constant)	4.493	.503		8.935	.000
	VSM	-.280	.102	.-.308	-2.756	.007
	JIT	-.301	.149	-.226	-2.023	.047
3.	(Constant)	3.962	.549		7.214	.000
	VSM	-.309	.100	.-.340	-3.092	.003
	JIT	-.373	.149	-.280	-2.506	.015
	LPS	.239	.111	241	2.143	.036

a. Dependant Variable: Project Cost

Table 4.9.5 present coefficient of results on project cost, from which the linear regression equation below is derived.

Project Cost = 3.962 + 0.239 LPS -0.373 JIT -0.309 VSM + ε

This study concluded that all factors used in this study held at a constant of 3.962, an increase in the level of last planner system by 23.9% and a decrease in the level of just in time system and value stream mapping by 37.3% and 23.9% respectively would increase the project cost of the firm.

4.7 Discussion of Findings

From this findings, the study concludes that quality management tools and just in time systems are moderately implemented in the construction sector, while low extent of last planner system and value stream mapping was being implemented by some firms. The study further revealed that last planner system, a lean production practice mainly applicable in the construction industry than the manufacturing and service sector is not highly implemented in the Kenyan market as is applicable in developed countries.

With the adjusted R square of 0.134 and 0 .18 on project completion time and project cost respectively existence of a weak positive relationship between the variables was affirmed. The study also agreed with the hypothesis that lean production is positively associated with operational performance of construction firms.

The findings also found that the lean production practices implemented didn't have equal influence on cost and time performance indicators. While some lean practice influenced time, others didn't and the vice versa. However, the overall significance found in this study is believed to influence the financial performance of the firm. Due to the low significance influence on project time and project cost, it is likely that construction firms in Nairobi experienced some forms of project delay and cost overrun.

Findings of this study found that implementation of lean production practices positively influenced operation performance of construction firms. Majority of the surveyed firms reported improved customer satisfaction as the leading benefits from the implementation. On the other hand, it was found that, lack of long term sustainability strategy and unfamiliarity with the implemented lean tool were the key hindrances to successful implementation of lean production in the construction sector.

In view of the above findings, this study agree with findings made by Shah and Wards (2003) recommending a holistic adoption of an entire lean system due to the synergy obtained rather than an individual lean tool. In addition, as predicted by Fullerton, Kennedy and Widener (2004) contingency theory, firms should ensure that lean practices being implemented fits the firms' strategy and long term objectives.

The findings of this study agree with Porwalet al.(2010) and Zhang and Chen (2016) study that inadequate knowledge on implemented lean tools in a firm hider their maximum efficiency. In addition, Oladiran (2008) found that knowledge on lean practices in the construction sector in Nigeria wasn't well disseminated; hence the unfamiliarity with the lean tools influenced LP efficiency. For construction firms in Nairobi to enhance sustainable development, they should ensure that all employees are familiar with the lean practices implemented and establish long term strategies to sustain the practices implemented.

Finally, the researcher confirms that lean production implementation is significant to improved performance of large and medium sized construction firms in Nairobi. The study found that firms should pay keen attention to the lean tool being implemented to ensure it influenced operation performance result. This is because while implementation of last planners system influenced project cost, it has low influence on project time. A holistic approach where the firm implements more than one lean tool based on the expected performance is highly recommended.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter present a summary of the research objectives based on the findings of data analysis, discussing the impact of lean production tools and operational performance of large and medium sized construction firms. In addition, it provides general practice conclusions, highlighted limitations of the study as well as the researcher's recommendations on the study.

5.2 Summary of the Findings

The objective of this study was to establish the perceived relationship between lean production practices and operational performance of large and medium sized construction firms in Nairobi. The descriptive findings of this research revealed that building works is the largest registered construction category satisfying the registration expectations. Majority of the respondents were project/ construction managers with a work of experience of 6-10 years which provided confidence in the information provided by the respondents. The study further conclude that most of the construction firms are medium sized Kenyan firms with an employee population of 50-100 majority of whom are degree holders.

In regards to implementation of lean production practices, quality management tools was widely implemented while value stream mapping was least implemented by the surveyed firms. This finding confirmed that implementation of lean production practice aiming at elimination of waste was vital in customers' expectations satisfaction. The study further revealed that implementation of lean practices resulted to higher extent of customer satisfaction; however, lack of long term sustainability strategy on the implemented lean production practice was widely argued to impede implementation of lean production practices.

The study revealed that the extent to which lean production practices influenced operation performance indicators varied from one performance indicator to another. Critical importance should be paid on the LP practice being implemented to ensure it fits and meets the expected performance. The findings of this study analyzed the relationship between the variables through a multiple linear regression which found existence of a weak positive relationship between lean production practices and operational performance of the firm.

5.3 Conclusion

This research study found that quality management tools and just in time systems were moderately implemented and significantly influenced the operational performance of construction firms, while low extent influence was experienced from implementation of last planner systems and value stream mapping.

The findings concluded that implementation of lean practices greatly benefited the firms from improved customer satisfaction, assignment of realistic work and reduced production cost. In addition, the study found that firm performance was negatively influenced by lack of long term lean sustainable strategy, unfamiliarity with lean practices applied and inadequate resources available.

The study concludes that a weak positive significance exist between lean production practices influencing 13.4% and18% of the project completion time and project cost of the construction firms in Nairobi.

5.3 Recommendation

The findings of this study found that quality management tools and just in time systems were moderately implemented by large and medium sized construction firms in Nairobi. The researcher recommends implementation of quality management tools to a greater extent due to its benefits on customer satisfaction. However, its implementation should be accompanied by a fitting lean production practice that will influence other performance indicators of the firm.

Since a weak positive relationship exist between the two variables. The researcher recommends further studies to be conducted focusing on the relationship between the dependent variable and other lean production practices not included in this study, whose probable influence on project cost and fostering timely completion of projects can’t be underestimated. The researcher recommends implementation of lean production

practices by all construction firms, due to the benefits attained which leads to improved performance and the firms should focus on these benefits rather than the challenges hindering its implementation.

5.4 Limitation of the Study

Since this study was cross-sectional, a short period of the study time was available to conduct the research. In addition, data gathering was complicated by the bureaucratic systems in majority of the construction firm and the respondents' tight schedules. This resulted to delays in completing and returning the questionnaires on time with some of the questionnaires not being returned. Most of the electronic questionnaires were ignored, hence, the researcher resolved to widely use large referral network accompanied by the introduction letter from the University to reach the surveyed firms. Most of the respondents were uncomfortable sharing information about their firms despite the assurance that the data was confidential and would only be used for academic purposes. Majority of the respondents feared that the data would reach their competitors or unauthorized recipients.

5.5 Suggestion for Further Studies

The researcher recommends further studies to be conducted to establish why similar independent variables influence performance of cost and time different and how to distinguish the ideal fit of the two variables to be used in a holistic approach. This will help large and medium sized firms not base their choice of trial due to the capital investment involved.

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APPENDICES

Appendix I: Research Questionnaire

Kindly provide to the best of your knowledge appropriate response to this questionnaire. Your response will be confidentially handled for academic purpose of this study regarding lean production practices and firm performance.

Please complete all the questions as they are equally important to this study.

PART A Bio Data

1. From the list below, please tick your company category.

   Building Works [ ] Mechanical Engineering [ ]

   Road Works [ ] Electrical Engineering [ ]

   Water Works [ ] Electrical Works [ ]

   Others (specify)……

2. Position held by the respondent

   Project/ Construction Manager [ ] Operations Manager [ ]

   Others (specify)……

3. For how long have you served this firm?

   Below 5 years [ ] 6-10 years [ ]

   Above 10 years [ ]

4. How many employees are currently employed by your firm?

   Below 50 employees [ ]

   50-100 employees [ ]

   Above 100 employees [ ]

5. Appropriately tick your education level.

   Diploma [ ] Undergraduate [ ]

   Graduate [ ] Doctorate [ ]

6. From the category below, please tick the best description of the nature of your firm

   Kenyan Owned firm [ ] Foreign Owned firm [ ]

7. Indicate the total project value annually executed by your firm. _____

PART B Lean Production Practices

8. By ticking in the appropriate box, please rank the extent to which your firm has implemented these lean production practices. Using a scale of; 5=Very high extent, 4= high extent, 3= moderate extent, 2= low extent and 1= very low extent

Lean Production Practices/ tools		**5**	**4**	**3**	**2**	**1**
Last Planner System	Weekly work flow is planned on look ahead schedule based on staffs capability					
	The firm regularly reviews causes of completed and uncompleted tasks					
	The firm takes into consideration recommendations made for assigned tasks.					
Just In Time Systems	The firm ensures right inventory is availed at the time required.					
	The firm maintains strong relationships with its supply partners.					
	The firm maintains minimum inventory.					

Value Stream Mapping	The firm has efficient flow of information and material.					
	There is visualization of work on progress at each stage trough constant checks to reveal hidden problems in workflow.					
Quality Management Tools TQM PDCA	The firm applies TQM principles (customer focus, people involvement and continuous improvement) to deliver quality construction projects.					
	The firm has strong ability in plan-do-check and acts findings to continuously improve project quality.					
Any other (specify)						

9. How long has your firm implemented lean practice?

Below 5 years [ ]

6-10 years [ ]

Above 10 years [ ]

10. Appropriately rank how your firm has benefited from implementing lean production tools. Using a scale of; 1=Very high influence, 2= Good influence, 3= moderate influence, 4= poor influence and 5= very poor influence

Benefits	**5**	**4**	**3**	**2**	**1**
Better knowledge creation					
Realistic work assignment					
Improving customer satisfaction					
Better flow of work					
Reduced production cost					
Any Other (Please specify)					

11. Please rank extent to which the challenges below have influenced implementation of lean production in your firm. Using a scale of; 1=Strongly Agree, 2= Agree, 3= Neutral, 4= Disagree and 5=Strongly Disagree

Challenges	**5**	**4**	**3**	**2**	**1**
Lack of top management support/ leadership					
Unfamiliarity with lean tool (s) applicable					
Inadequate knowledge and training on lean production					
Lack of long term lean sustainability strategy					
Inadequate resources					
Any Other (Please specify)					

Section C: Operational Performance

12. Please evaluate the indicators below and rank how your firm has been performing on each. Using a scale of; Using a scale of; 5=Very good performance, 4= good performance, 3= moderate performance, 2= poor performance and 1= very poor performance

Performance Measurement	**5**	**4**	**3**	**2**	**1**
Average % completion Time Variance					
Average % project cost Variance					
Any other (Please specify)					

Your Time and Participation is highly appreciated!!