

Implementing Lean Project Management Techniques in Nigerian Manufacturing Industries

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Abstract

The increasing competitiveness of the global manufacturing industry has necessitated the adoption of efficient management practices to enhance productivity, minimize waste, and optimize the utilization of organizational resources. This study examined the implementation of Lean Project Management techniques in Nigerian manufacturing industries, with particular focus on Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc. The study adopted a descriptive survey research design. The target population comprised 1,099 staff of the two selected manufacturing companies in Port Harcourt, Nigeria. Using the Cochran sample size formula, a sample size of 285 respondents was determined, while simple random sampling was employed in selecting the respondents. Data were collected primarily through a structured questionnaire covering the socio-demographic characteristics of respondents and the implementation of selected Lean Project Management techniques. The reliability of the research instrument was assessed using Cronbach's Alpha coefficient. Data collected were analysed using descriptive statistics, while the hypotheses were tested using the One-Sample t-test. The findings revealed that Value Stream Mapping (VSM) was not significantly implemented in the selected Nigerian manufacturing industries, whereas Just-in-Time (JIT) and Root Cause Analysis (RCA) were significantly implemented. The study concluded that although some Lean Project Management techniques have been adopted in Nigerian manufacturing industries, the implementation of VSM remains inadequate. The study therefore recommended that Nigerian manufacturing industries should invest in comprehensive training and capacity-building programmes to enhance employees' awareness, knowledge, and practical understanding of Lean Project Management techniques, particularly Value Stream Mapping, thereby improving operational efficiency and waste reduction

Keywords: Lean Project Management, Value Stream Mapping, Just-in-Time, Root Cause Analysis, Manufacturing Industries.

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Introduction

The competitive landscape of the global manufacturing industry has necessitated the adoption of efficient management practices to enhance productivity, reduce waste, and optimize resource utilization (Abbas, Ismail, Taqi, & Yazid, 2023). Lean Project Management (LPM) techniques, rooted in the principles of Lean Manufacturing, have emerged as a critical strategy for achieving operational excellence (Januszek, Netland & Furlan, 2024). These techniques focus on minimizing waste, improving process efficiency, and delivering value to customers (Kumar, Babu, Paranitharan, & Kumar, 2024). In the context of Nigerian manufacturing industries, the implementation of Lean Project Management has the potential to drive significant improvements in productivity and sustainability.

This study focuses on the implementation of Lean Project Management techniques in two prominent manufacturing industries in Port Harcourt, Nigeria: Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc. Both companies play a crucial role in Nigeria's industrial landscape, contributing significantly to the nation's economy through their production of petrochemicals and fertilizers, respectively (Dumka & Neeka, 2017). Despite their importance, these industries face challenges such as resource inefficiencies, high production costs, and intense competition, making the adoption of Lean techniques increasingly relevant.

Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc are two of Nigeria's leading manufacturing companies, operating within the chemical and petrochemical sectors. IEPL, a subsidiary of Indorama Corporation, is one of Africa's largest petrochemical companies, engaged in the production of polymers and chemicals. Notore Chemical Industries Plc, on the other hand, is a key player in Nigeria's fertilizer market, with a focus on the production and distribution of nitrogenous fertilizers and allied chemicals (Dumka & Neeka, 2017).

The manufacturing sector in Nigeria is characterized by a range of challenges, including fluctuating energy supply, high production costs, and infrastructural deficits (Boluwaji, *et al.* 2024). These issues often lead to inefficiencies and waste, hindering the overall productivity and competitiveness of the sector. Lean Project Management, with its emphasis on waste reduction, process optimization, and continuous improvement, offers a viable solution to these challenges (Queiroz, *et al.* 2024).

Lean Project Management techniques, which originated from the Toyota Production System (TPS), have been successfully implemented in various industries worldwide to streamline operations and enhance efficiency. However, the application of these techniques in the Nigerian context, particularly in the manufacturing sector, remains limited. This study aims to explore the potential benefits, challenges, and strategies for implementing Lean Project Management techniques in IEPL and Notore Chemical Industries Plc. By examining these case studies, the research seeks to provide insights into how Nigerian manufacturing companies can leverage Lean principles to improve their operational efficiency, reduce costs, and enhance their competitive advantage..

Statement of the Problem

The Nigerian manufacturing sector faces major challenges, including production inefficiencies, high operating costs, and excessive waste, which reduce profitability and competitiveness (Ogar, Okoi, & Ite, 2024; Obasi, 2023). Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc also experience these challenges due to outdated production methods, resource wastage, and ineffective project management practices.

Lean Project Management (LPM), which emphasizes waste reduction, process optimization, and continuous improvement, offers a potential solution (Alshurideh *et al.*, 2023). However, its adoption in Nigerian manufacturing remains limited, partly due to inadequate local research and implementation frameworks.

Therefore, this study investigates the implementation of LPM techniques at IEPL and Notore Chemical Industries Plc, focusing on the barriers to adoption and strategies for overcoming them. The study aims to provide practical insights for improving efficiency, reducing waste, and enhancing competitiveness in Nigerian manufacturing.

Objectives of the Study

The broad objective of this study is to explore and evaluate the implementation of Lean Project Management techniques in Nigerian manufacturing industries, specifically focusing on Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc. The specific objectives are:

- i. To ascertain the extent of the implementation of Value Stream Mapping (VSM) in Nigerian manufacturing industries.
- ii. To ascertain the extent of the implementation of Just-In-Time (JIT) in Nigerian manufacturing industries.
- iii. To evaluate the extent of the implementation of Root Cause Analysis (RCA) in Nigerian manufacturing industries.

Research Questions

Based on the objectives outlined above, the study seeks to answer the following research questions:

- i. To what extent has Nigerian manufacturing industries implemented Value Stream Mapping (VSM)?
- ii. To what extent has Nigerian manufacturing industries implemented Just-In-Time (JIT)?
- iii. To what extent has Nigerian manufacturing industries implemented Root Cause Analysis (RCA)?

Hypotheses of the Study

The following hypotheses were tested in the cause of the study

H0₁: Value Stream Mapping (VSM) is not significantly implemented in Nigerian manufacturing industries.

H0₂: Just-In-Time (JIT) is not significantly implemented in Nigerian manufacturing industries.

H0₃: Root Cause Analysis (RCA) is not significantly implemented in Nigerian manufacturing industries.

Significance of the Study

This study contributes to academic knowledge and practical applications in the Nigerian manufacturing sector by examining the implementation of Lean Project Management techniques—Value Stream Mapping (VSM), Just-In-Time (JIT), and Root Cause Analysis (RCA)—at Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc.

The findings provide insights into how Lean techniques can reduce waste, improve production efficiency, and enhance productivity and competitiveness. The study also addresses the limited research on Lean practices in Nigeria by providing evidence of their application and associated challenges.

The findings can assist manufacturing managers and policymakers in making informed decisions and developing strategies that encourage Lean adoption. Improved efficiency and reduced costs can contribute to company profitability, consumer benefits, and Nigeria's broader industrial and economic development. Additionally, the study can serve as a useful resource for academic and professional training in Lean Project Management.

Scope of the Study

The scope of this study on implementing Lean Project Management techniques in Nigerian manufacturing industries is defined by the following parameters:

The study focuses on two prominent manufacturing companies located in Port Harcourt, Nigeria: Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc. The research is limited to these companies, providing an in-depth analysis within the context of the Nigerian manufacturing sector. The study specifically

examines the implementation of Lean Project Management (LPM) techniques within IEPL and Notore. It covers various aspects of LPM, including Value Stream Mapping (VSM), Just-In-Time (JIT) and Root Cause Analysis (RCA).

Literature Review

Conceptual Review

Lean Project Management (LPM) represents a transformative approach to optimizing operational efficiency and minimizing waste across industries. Originating from the Toyota Production System, Lean methodologies have been widely adopted globally, with significant impact on manufacturing processes. This review explores the conceptual underpinnings of three core Lean techniques—Value Stream Mapping (VSM), Just-In-Time (JIT), and Root Cause Analysis (RCA)—and examines their relevance and application within the context of Nigerian manufacturing industries.

Lean Project Management

Lean Project Management (LPM) is a methodology designed to optimize the efficiency and effectiveness of projects by minimizing waste and maximizing value. Originating from Lean Manufacturing principles developed by Toyota, LPM extends these concepts to project management to improve processes, enhance outcomes, and deliver more value to stakeholders (Du, Zhang, Castro-Lacouture, & Hu, 2023).

Principles of Lean Project Management

At the core of Lean Project Management are several key principles that guide the methodology:

Value Identification

The primary focus of Lean Project Management is to deliver value from the perspective of the customer. Value is defined as any action or process that a customer would be willing to pay for. By identifying and prioritizing these value-driven activities, LPM ensures that project efforts are aligned with customer needs and expectations (Shahin, Maghanaki, Hosseinzadeh, & Chen, 2024).

Value Stream Mapping

Value stream mapping involves analyzing the flow of materials and information required to bring a product or service from conception to delivery. This technique helps in identifying and eliminating waste within the process, streamlining operations, and enhancing overall efficiency (Hegedić, Gudlin, Golec, & Tošanović, 2024).

Waste Reduction

Lean methodology emphasizes the reduction or elimination of waste—defined as any activity or resource that does not add value to the end product. Waste can manifest in various forms, such as excess inventory, waiting times, unnecessary transportation, overproduction, defects, and inefficient processes. By addressing these areas, Lean Project Management aims to create a more streamlined and productive workflow (Singh, Kumar, Mittal, & Verma, 2024).

Continuous Improvement (Kaizen)

The principle of continuous improvement, or Kaizen, advocates for ongoing incremental changes that lead to enhanced performance and value. In Lean Project Management, this involves regularly assessing processes, soliciting feedback, and making iterative improvements to drive efficiency and effectiveness (Hegedić, Gudlin, Golec, & Tošanović, 2024).

Empowering Teams

Lean Project Management encourages the involvement and empowerment of team members in decision-making processes. By leveraging the expertise and insights of those directly involved in the work, organizations can foster a culture of collaboration and innovation, ultimately leading to better project outcomes (Hegedić, Gudlin, Golec, & Tošanović, 2024).

Practices and Tools

According to Aziz, Nasreldin and Hashem (2024), lean project management employs a variety of practices and tools to achieve its objectives:

Kanban

Kanban is a visual management tool used to control work processes and workflow. It uses visual signals, such as cards or boards, to represent tasks and their progress. This approach helps in managing work-in-progress, identifying bottlenecks, and ensuring a smooth flow of tasks through the project lifecycle.

Just-in-Time (JIT)

Just-in-Time is a production strategy that aims to reduce inventory levels and production costs by producing only what is needed, when it is needed. In project management, JIT can be applied to deliverables and resources to minimize waste and improve responsiveness to changing requirements.

Root Cause Analysis

Root cause analysis is a problem-solving technique used to identify the underlying causes of issues or defects. By addressing these root causes, organizations can implement effective solutions and prevent recurrence, leading to improved project performance and outcomes.

A3 Problem Solving

A3 problem solving is a structured approach to addressing and resolving issues. It involves documenting the problem, analyzing the current situation, developing solutions, and implementing and evaluating the results. The A3 format provides a concise and visual way to communicate and manage problem-solving efforts.

Benefits of Lean Project Management

According to Badran and Abdallah (2024), Lean Project Management offers several benefits that can significantly impact project success and organizational performance:

Increased Efficiency

By focusing on waste reduction and process optimization, Lean Project Management helps streamline operations, resulting in faster project delivery times and reduced costs. This efficiency leads to better resource utilization and more effective project execution.

Enhanced Quality

Lean principles emphasize continuous improvement and the elimination of defects. By addressing root causes and implementing quality control measures, organizations can achieve higher-quality deliverables and meet customer expectations more effectively.

Greater Customer Satisfaction

Lean Project Management prioritizes delivering value to the customer. By aligning project activities with customer needs and preferences, organizations can enhance customer satisfaction and build stronger relationships.

Improved Team Collaboration

The empowerment of team members and the emphasis on collaboration foster a positive work environment. Lean practices encourage open communication, shared responsibility, and collective problem-solving, leading to more cohesive and motivated teams.

Flexibility and Adaptability

Lean Project Management promotes responsiveness to change and adaptability to evolving requirements. This flexibility allows organizations to adjust project plans and processes as needed, improving their ability to handle uncertainties and emerging opportunities.

Theoretical Review

Theory of Constraints (TOC)

The Theory of Constraints, developed by Goldratt (1984), is a theoretical framework that complements Lean principles. TOC focuses on identifying and addressing the most critical constraint or bottleneck in a process to improve overall performance. The concept is applied in Lean Project Management to optimize workflows by eliminating constraints that hinder project progress. TOC emphasizes identifying the primary constraint or bottleneck in a system and addressing it to enhance performance. Lean Project Management also seeks to streamline processes by eliminating inefficiencies and waste. By applying TOC principles, LPM can better pinpoint and address specific areas where delays or inefficiencies occur, leading to more effective improvements. TOC's

principle of ongoing improvement aligns with the Lean practice of continuous improvement (Kaizen). Both approaches advocate for iterative enhancements and ongoing efforts to refine processes. Applying TOC within a Lean framework can reinforce the commitment to continuous improvement and help sustain long-term gains.

Systems Theory

Systems Theory propounded by Bertalanffy in 1968 provides a holistic view of organizations and projects as interconnected systems. It emphasizes the relationships and interactions between different components and how changes in one part of the system can affect the whole. In Lean Project Management, Systems Theory helps in understanding the broader impact of process changes and ensuring that improvements in one area do not create problems elsewhere. Lean Project Management benefits from Systems Theory by adopting a holistic perspective. This means that Lean practices consider how improvements in one area of a project impact the entire system. For example, value stream mapping in Lean Project Management visualizes end-to-end processes, helping identify how changes in one part of the workflow affect others. This holistic view ensures that process improvements are integrated and do not create new inefficiencies elsewhere in the system.

Complexity Theory

Complexity Theory propounded by Mitchell in 1992 explores how complex systems behave and evolve over time. It focuses on understanding the dynamics of systems with many interacting components and the emergent behaviors that result from these interactions. Lean Project Management applies Complexity Theory to manage uncertainty and adapt to changing project environments. Complexity Theory provides valuable insights into managing complex projects by emphasizing the importance of emergent behavior, adaptability, feedback loops, nonlinearity, interconnectedness, and dynamic interactions. Lean Project Management integrates these concepts to enhance its approach to process improvement, adaptability, and overall project performance. By applying principles from Complexity Theory, Lean Project Management can more effectively navigate the complexities of modern projects, anticipate and respond to changes, and optimize outcomes through iterative learning and improvement.

Empirical Review

This section of the study is focused on reviewing past studies on the application of lean management techniques in selected industries in the globe.

Value Stream Mapping Applicability

Ullah et al. (2024) examined the application of Value Stream Mapping (VSM) in the electronics manufacturing industry to improve operational efficiency and financial performance. Using data collected from the manufacturing floor, the study developed current and future state maps to identify and eliminate non-value-added activities. The findings showed that combining VSM with Lean principles reduced production lead time by 67.84% and costs by 8.69%, demonstrating its potential to improve competitiveness and customer responsiveness.

Habib, Rizvan, and Ahmed (2023) applied VSM and other Lean tools in a labeling and packaging company in Bangladesh to improve productivity and quality. The study focused on reducing lead time, customer complaints, production defects, and waste while increasing productivity. The use of VSM, Kanban, SMED, and root-cause analysis reduced waiting and motion waste and improved production quality. Overall, the approach improved lead time, ICR, and CCR by 7.1%, 55%, and 83%, respectively.

Islami (2024) investigated how strategic supplier partnerships and information sharing influence the relationship between Lean manufacturing and financial performance. Based on data from 157 manufacturing firms, the study found that strategic supplier partnerships partially mediate the relationship between Lean manufacturing and financial performance. However, information sharing was not found to significantly moderate this relationship.

Just-In-Time Applicability

Huson (2023) examined the impact of Just-in-Time (JIT) on firms' accounting performance measures. The study found that JIT adoption reduced labor content, increased inventory turnover, and improved earnings. However, it had no significant effect on prices charged by firms. These findings support the positive contribution of JIT to firm performance, even during periods of declining business performance.

Anderson (2019) reviewed the relationship between Just-in-Time (JIT), Total Quality Management (TQM), Supply Chain Management (SCM), and organizational performance. The study reviewed **65 articles** from major academic databases, including Scopus, ScienceDirect, Emerald, and Springer. The findings showed that JIT, TQM, and SCM practices, individually and collectively, positively influence operational and organizational performance in both manufacturing and service industries.

Cheptoo, Kiongera, and Rutto (2024) investigated the influence of JIT on supply chain performance in 11 sugar manufacturing firms in Western Kenya. Using data from 95 employees, the study applied correlation and regression analysis. The findings showed a significant relationship between JIT and supply chain performance ($p = 0.001 < 0.05$). An increase in JIT practices resulted in a measurable improvement in supply chain performance, confirming that JIT contributes positively to supply chain efficiency.

Root Cause Analysis Applicability

Vahidi, Mirhashemi, Noorbakhsh, and MolaviTaleghani (2018) investigated the use of Root Cause Analysis (RCA) in addressing clinical errors. Using a qualitative retrospective approach, the study analyzed 7 sentinel events and identified 30 healthcare-related problems. Care-related problems were the most common (45.4%), while knowledge and skill problems were the least common (14.5%). Among 406 identified causes, organizational factors were the most frequent (**20.1%**), while patient-related factors were the least frequent (6.1%). The study recommended interventions focused mainly on human resource management and improving clinical processes.

Ernest (2020) examined the effect of Root Cause Analysis as a Lean management practice on firm performance in beverage manufacturing firms in Accra. Using data from 162 participants, the study employed Pearson correlation and structural equation modelling (SEM). The findings showed that RCA positively influenced operational and financial performance, but had no significant effect on marketing performance. Firm characteristics such as size, age, operational capital, and total assets also had no significant effect. The study concluded that strengthening Lean management and employee training can improve firm performance

Summary of Literature Review

Table 1. Summary of Empirical Review

Author	Year of Study	Objective	Methodology	Finding
Ullah, et al.	2024	To analyze the application of Value Stream Mapping (VSM) within the context of the electronics manufacturing industry	Descriptive Statistics	The study reveals that embracing Lean principles, in conjunction with Value Stream Mapping, can significantly benefit the electronics manufacturing industry.
Habib, Rizvan, and Ahmed	2023	Lean manufacturing approach via value stream mapping (VSM) in a labeling and packaging company in Bangladesh	Descriptive Statistics	The study shows that proper applications VSM, Kanban, setup time reduction single-minute-exchange-of-die (SMED) approach and why-why analysis can bring about significant improvement in KPIs.
Islami	2024	Mediating role of strategic supplier partnership and moderating role of information sharing (IS)	Structural Equation Modeling (SEM)	The study finds that strategic supplier partnership partially mediates the relationship between lean manufacturing and FP,
Huson	2023	Impact of JIT on accounting measures of performance.	SEM and Descriptive Statistics	The results show that after JIT adoption firms reduced the labor content in facilities, increased inventory turnover

				and enhanced earnings.
Anderson	2019	The relationship and practices of Just-in-Time and firm performance	Content Analysis	The results showed that JIT, TQM and SCM practices in both manufacturing and service industry individually and jointly impact organizational performance.
Cheptoo, Kiongera, and Rutto	2024	Influence of just-in-time on supply chain performance	Pearson correlation and linear regression analysis	The research revealed that an increase in just-in-time results in a measurable enhancement of 0.078 in supply chain performance, according to the study ((85) = 7.312.
Vahidi, Mirhashemi, Noorbakhsh, and MolaviTaleghani	2018	Clinical errors: implementing root cause analysis in an area health service.	Descriptive Statistics	For the 7 sentinel events, 30 problems related to the service or healthcare was identified. Out of the 30 identified problems, the most problem related to care problems (45.4%) and the least frequent problem related to knowledge and skill problems (14.5%).
Ernest	2020	Influence of lean operations adopting root cause analysis on firm performance, considering some business characteristics-controlled variables.	Pearson's correlation test and structural equation modelling (SEM)	The study found that root cause analysis had a positive effect on operational and financial performance but not marketing performance.

Gap in Literature

Much of the existing research on Lean Project Management is concentrated in industrialized regions, such as Japan, the United States, and Europe. Studies often focus on advanced manufacturing environments where Lean practices have been extensively developed and refined. While these studies provide valuable insights into the general principles and benefits of Lean methodologies, they may not fully address the specific conditions and constraints faced by manufacturing industries in Nigeria.

There is a lack of comprehensive research that specifically explores the implementation of Lean techniques within the Nigerian context. Studies that address the adaptation of VSM, JIT, and RCA to the unique challenges of Nigerian manufacturing, such as infrastructural limitations, economic instability, and supply chain issues, are sparse. This gap in the literature means that there is insufficient understanding of how these techniques can be effectively adapted and applied in Nigeria's manufacturing sector.

Methods and Procedure

Research Design

Research design is a plan and structure that guides the investigator in the process of data collection, analysis and interpretation. It is a logical model or proof that permits the researcher to draw inferences concerning causal relationship among variables being investigated (Njoku, 2014). The study adopted a descriptive survey design. The method ensured that the researcher collects his data at a particular period from the selected sample to describe a large population at that particular point in time. The method was employed because it enabled the researcher to use the sample drawn to represent the diverse elements of the population under study.

Area of Study

This study focuses on the application of Lean Project Management techniques—specifically Value Stream Mapping (VSM), Just-In-Time (JIT), and Root Cause Analysis (RCA)—within Nigerian manufacturing industries. The study will be conducted within the context of two major companies: Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc, both located in Port Harcourt, Nigeria. These companies represent significant players in Nigeria's manufacturing sector, involved in the production of petrochemicals and fertilizers respectively. The geographical focus of this study is Port Harcourt, Nigeria. Port Harcourt, the capital of Rivers State, is a key industrial hub in the Niger Delta region, known for its significant contributions to Nigeria's manufacturing and petrochemical industries. The choice of this location is due to the presence of major manufacturing firms such as IEPL and Notore Chemical Industries Plc, which are pivotal to the local and national economy.

Population of the Study

Isiwu (2010) describes population as the totality of subjects which meet a given set of criteria. The target population of this study consists of the staff of the two selected manufacturing companies in Port Harcourt Nigeria. Table 3.1 below is a display of the total population distribution of the study.

Table 3.1: Population of the Selected Manufacturing Industries

University	Staff Size
Indorama Eleme Petrochemicals	590
Notore Chemical Industries	509
Grand Total	1099

Source: Firms' Human Resource Department, 2024.

Sample Size Determination

For this research, the sample size was derived using Cochran sample size formula. This is given as:

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \dots\dots\dots (3.1)$$

Where:

n_0 = Representative sample for proportion n = Sample Size, N = Population Size, e = Allowable sampling error taken at 5% = 0.05, p = Proportion of success in the population from pilot survey = 0.50, q = proportion of failure in the population from pilot survey = 0.50

However:

$$n_0 = \frac{Z^2 pq}{e^2} \dots\dots\dots (3.2)$$

Where; Z^2 is the abscissa of the normal curve (1.96), q is 1- p and e is the allowable sample error (0.05). Substituting these values into equation 3.2, we have:

$$n_0 = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 385 \dots\dots\dots (3.3)$$

Substituting $n_0 = 385$ from equation 3.3 into equation 3.1, we have:

$$n = \frac{385}{1 + \frac{(385 - 1)}{1099}}$$

$$n = \frac{385}{1 + 0.3494085532}$$

$$n = \frac{385}{1.3494085532} = 285$$

Having applied the Cochran sample size derivation statistic, the value derived was two hundred and eighty-five (285).

Sampling Technique

The researcher in the course of conducting this study used the simple random sampling techniques. Simple random sampling was used as the sampling technique for the reason that the method ensures equal chance of selection among the respondents but also, the method avoid and minimize bias hence enhances validity and reliability.

Instrument for Data Collection

For the purpose of this study, primary data was employed. The data was collected with the aid of a questionnaire that is properly drafted using the 5-point Likert scale for the questionnaire. The questionnaire was adopted because it has the following advantages such as, it allows for large number of information to be collected from a large number of people in a short time period, the results of the questionnaire can be quickly and easily quantified by the researcher, can be analyzed scientifically and when the data has been quantified, it can be used to compare and contrast other researches.

Method of Data Collection

The major instrument for data collection in this study was the questionnaire. The questionnaire covered information on the socio-demographic characteristics of the respondents. The questionnaire will be designed to have two sections. Specifically, all questions in section 'A' were drawn to provide some general and demographic information of the respondents, while the remaining questions in section 'B' were formed and directed to address the research questions. The instrument was designed in a 5-point likert scale format. The scales ranged from 5(Strongly Agree) to 1(Strongly Disagree).

Validity of the Instrument

Validity refers to the ability of a scale to measure what it is designed to measure. The validity of measurement will be established through content validity which was given to other researchers to ascertain whether the questionnaire item adequately cover the domain of the construct. The research instrument was also certified by researcher's supervisor and experts in statistics, measurement and evaluation to ensure validity of questionnaire items. This was subjected to expert opinion to test the face and content validity. However, Average Variance Extracted (AVE) > 0.5 was treated as additional evidence of convergent validity, the construct validity of all variables involved in the study were therefore ascertained. Discriminant validity was also assessed by comparing the AVE with the squared correlations between the two constructs and it was less than the AVEs, which suggests that the constructs were distinct.

Reliability of the Instrument

A reliability test will be conducted on the instrument to determine how consistent the responses are. The researcher will utilize test/retest method of reliability testing whereby the questionnaire will be administered at two different times to the same group of respondents. The Cronbach Alpha reliability test will be utilized to conduct the reliability test. A cronbach alpha coefficient of 0.50 or more will be considered acceptable.

Method of Data Analysis

Data collected from the questionnaire were analyzed, summarized, and interpreted accordingly with the aid of descriptive statistical and One-Sample t-test was used to test the hypotheses. A one-sample t-test is a statistical method used to determine whether the mean of a single sample is significantly different from a known or hypothesized population mean (Al-Kassab, 2022). This test is particularly useful when you want to compare the

mean of a sample to a known value, such as a population mean, to see if there is evidence that the sample comes from a different population (Al-Kassab, 2022).

Decision Rule

Reject the null hypothesis (H_0) if the p-value < 0.05

Do not reject H_0 if otherwise.

Data Presentation and Analysis

Data Presentation

In this part of the research, information generated through the distribution of well-structured questionnaires was analyzed using the tabled frequencies and corresponding percentages of the demographic characteristics of the respondents.

Questionnaire Return Rate

In the course of the study, questionnaires were distributed to the various sampled banks and given the uncertainties beclouding survey studies, not all questionnaires distributed were returned and properly filled. This section of the study displays the statistics of distributed and returned questionnaire and their corresponding percentages. This is shown in table 1 below.

Questionnaire Distributed	Questionnaire Returned	Response Rate (%)
285	274	96%

It can be clearly seen from the table above that 285 copies of the questionnaire were distributed to the targeted respondents and 274 were returned with a corresponding rate of 96%. This is high and significant.

Table 2: Value Stream Mapping (VSM) is effectively implemented in our production processes.

Item	Frequency	Percentage
Strongly Agree	15	5
Agree	12	4
Undecided	6	2
Disagree	109	40
Strongly Disagree	132	48
Total	274	100

Source:Field Survey, 2024.

From table 2, 15(5%) of the respondents strongly agree that Value Stream Mapping (VSM) is effectively implemented in their production processes, 12(4%) agree, 6(2%) are undecided, 109(40%) disagree, and 132(48%) strongly disagree. This entails on the average that majority of the respondents disagree that Value Stream Mapping (VSM) is effectively implemented in their production processes.

Table 3: Just-In-Time (JIT) practices have reduced inventory levels in our company.

Item	Frequency	Percentage
Strongly Agree	187	68
Agree	69	25
Undecided	6	2
Disagree	8	3
Strongly Disagree	4	1
Total	274	100

Source:Field Survey, 2024.

It can be deduced from table 3 that 187(68%) of the respondents strongly agree that Just-In-Time (JIT) practices have reduced inventory levels in their company, 69(25%) agree, 6(2%) are undecided, 8(3%) disagree, and 4(1%) strongly disagree. This entails on the average that majority of the respondents agree that Just-In-Time (JIT) practices have reduced inventory levels in their company.

Table 4: Root Cause Analysis (RCA) is regularly implemented to address production issues.

Item	Frequency	Percentage
Strongly Agree	174	64
Agree	100	36
Undecided	10	4
Disagree	58	21
Strongly Disagree	32	12
Total	274	100

Source:Field Survey, 2024.

It can be deduced from table 4 that 174(64%) of the respondents strongly agree that Root Cause Analysis (RCA) is regularly implemented to address production issues in their company, 100(36%) agree, 10(4%) are undecided, 58(21%) disagree, and 32(12%) strongly disagree. This entails on the average that majority of the respondents agree that Root Cause Analysis (RCA) is regularly implemented to address production issues.

Test of Hypotheses

Test of Hypothesis One

H0₁: Value Stream Mapping (VSM) is not significantly implemented in Nigerian manufacturing industries.

One-Sample Test

Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Value Stream Mapping	.327	29	.986	379.53333	67.2425	691.8242

Source: Researcher's Computation Using SPSS

From the above analysis, it is clearly seen that the probability value (Sig. 2 Tailed) yielded 0.9860 and it is greater than 0.05. This compels the acceptance of the null hypothesis (H0₁). Hence; Value Stream Mapping (VSM) is not significantly implemented in Nigerian manufacturing industries.

Test of Hypothesis Two

H0₂: Just-In-Time (JIT) is not significantly implemented in Nigerian manufacturing industries.

One-Sample Test

Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Just-In-Time (JIT)	14.000	29	<.001	1.86667	1.5940	2.1394

Source: Researcher's Computation Using SPSS

From the above analysis, it is clearly seen that the probability value (Sig. 2 Tailed) yielded 0.001 is less than 0.05. This compels the rejection of the null hypothesis (H_{02}) Hence; Just-In-Time (JIT) is significantly implemented in Nigerian manufacturing industries.

Test of Hypothesis Three

H0₃: Root Cause Analysis (RCA) is not significantly implemented in Nigerian manufacturing industries.

One-Sample Test						
Test Value = 0						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Root Cause Analysis (RCA)	13.590	29	<.001	2.20000	1.8689	2.5311

Source: Researcher's Computation Using SPSS

From the above analysis, it is clearly seen that the probability value (Sig. 2 Tailed) yielded 0.001 is less than 0.05. This compels the rejection of the null hypothesis (H_{02}) Hence; Root Cause Analysis (RCA) is significantly implemented in Nigerian manufacturing industries.

Discussion of Findings

Hypothesis One: The study found that Value Stream Mapping (VSM) is not significantly implemented in Nigerian manufacturing industries. This indicates a gap in Lean Project Management adoption, which may contribute to longer production times, higher costs, and reduced competitiveness. The finding contradicts Ullah et al. (2024), who reported significant use of VSM in the electronics manufacturing industry to improve operational and financial performance. It also differs from Habib, Rizvan, and Ahmed (2023), who found VSM effective in improving productivity and reducing waste in the labeling and packaging industry.

Hypothesis Two: The study found that Just-In-Time (JIT) is significantly implemented in Nigerian manufacturing industries. This suggests that firms are adopting JIT to optimize production, reduce waste, and improve efficiency. The finding agrees with Huson (2023), who found that JIT adoption reduced labor content, increased inventory turnover, and improved earnings. It also supports Anderson (2019), who reported that JIT, together with TQM and SCM, positively influences operational and organizational performance.

Hypothesis Three: The study found that Root Cause Analysis (RCA) is significantly implemented in Nigerian manufacturing industries. This suggests that firms are increasingly focusing on identifying and addressing the underlying causes of production problems, thereby improving long-term operational efficiency. The finding agrees with Vahidi et al. (2018) and Ernest (2020), who both reported positive outcomes from the application of RCA in improving processes and organizational performance.

Summary of Findings, Conclusion and Recommendation

Summary of Findings

Based on the study of implementing Lean Project Management techniques—Value Stream Mapping (VSM), Just-In-Time (JIT), and Root Cause Analysis (RCA)—in Nigerian manufacturing industries, specifically focusing on Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc, Port Harcourt, the following key findings were identified:

- i. VSM is not significantly implemented in Nigerian manufacturing industries. This finding indicates a gap in the adoption of Lean methodologies that focus on mapping and improving the flow of materials and information through the production process. The limited use of VSM suggests potential inefficiencies in identifying waste, bottlenecks, and areas for improvement in the production process. As a result, there may be missed opportunities for optimizing operations and achieving greater efficiency.
- ii. JIT is significantly implemented across Nigerian manufacturing industries, indicating a strong commitment to reducing waste and improving inventory management. The effective use of JIT suggests that these industries are achieving better alignment between production and demand, reducing excess inventory, and enhancing overall operational efficiency.
- iii. RCA is significantly implemented in Nigerian manufacturing industries, demonstrating a focus on identifying and addressing the underlying causes of problems within production processes. The widespread use of RCA contributes to improved problem-solving capabilities, better quality control, and a culture of continuous improvement within these industries.

Conclusion of the Study

The study concludes that Lean Project Management techniques are unevenly implemented in Nigerian manufacturing industries, particularly at Indorama Eleme Petrochemicals Limited (IEPL) and Notore Chemical Industries Plc, Port Harcourt. While Just-In-Time (JIT) and Root Cause Analysis (RCA) are significantly implemented, Value Stream Mapping (VSM) is not.

The implementation of JIT and RCA has improved inventory management, production efficiency, waste reduction, and continuous improvement. However, the limited use of VSM represents a gap in Lean adoption. Greater emphasis on VSM could help Nigerian manufacturing industries identify inefficiencies, improve processes, reduce costs, and achieve more sustainable operational performance.

Recommendations

Based on the findings and conclusions of the study on the implementation of Lean Project Management techniques in Nigerian manufacturing industries, the following recommendations were provided to enhance the effectiveness of Lean methodologies across the sector:

- i. Nigerian manufacturing industries should invest in extensive training programs to increase awareness and understanding of Value Stream Mapping (VSM). These programs should target all levels of the organization, from management to shop-floor employees.
- ii. Senior management in Nigerian manufacturing industries should demonstrate stronger commitment to the adoption of Lean techniques, including VSM, Just-In-Time (JIT), and Root Cause Analysis (RCA). This includes allocating necessary resources, time, and support for Lean initiatives.
- iii. Industries should start with pilot projects to implement VSM in specific areas of their production processes. Successful pilot projects can serve as models for broader implementation across the organization.

References

- Abbas, D. S., Ismail, T., Taqi, M., & Yazid, H. (2023). Determinant of company value: evidence manufacturing Company Indonesia. *Calitatea*, 24(192), 183-189.
- Al-Kassab, M. (2022). The use of one sample t-test in the real data. *Journal of advances in mathematics*, 21, 134-138.
- Alshurideh, M., Al-Hadrami, A., Alquqa, E., Alzoubi, H., Hamadneh, S., & Kurdi, B. (2023). The effect of lean and agile operations strategy on improving order-winners: Empirical evidence from the UAE food service industry. *Uncertain Supply Chain Management*, 11(1), 87-94.
- Aziz, R. M., Nasreldin, T. I., & Hashem, O. M. (2024). The role of BIM as a lean tool in design phase. *Journal of Engineering and Applied Science*, 71(1), 23.
- Badran, S. S., & Abdallah, A. B. (2024). Lean vs agile project management in construction: impacts on project performance outcomes. *Engineering, Construction and Architectural Management*.
- Boluwaji, O. D., Igbekoyi, O. E., Dagunduro, M. E., Busayo, T. O., & Osatuyi, O. A. (2024). Sustainable business practice and going concern of selected listed manufacturing companies in Nigeria. *International Journal of Emerging Trends in Social Sciences*, 16(1), 1-12.
- Cheptoo, C. R., Kiongera, F., & Rutto, R. K. (2024). Influence of Just-In-Time on Supply Chain Performance in Sugar Manufacturing Companies in Western Kenya. *African Journal of Empirical Research*, 5(2), 787-797.
- Du, J., Zhang, J., Castro-Lacouture, D., & Hu, Y. (2023). Lean manufacturing applications in prefabricated construction projects. *Automation in Construction*, 150, 104790.
- Dumka, N. J., & Neeka, J. B. (2017). Heavy metal concentrations in sediments from eleme creeks in relation to the eleme (indorama) petrochemicals company, rivers state, Nigeria. *IJCS*, 5(5), 377-380.
- Habib, M. A., Rizvan, R., & Ahmed, S. (2023). Implementing lean manufacturing for improvement of operational performance in a labeling and packaging plant: A case study in Bangladesh. *Results in Engineering*, 17, 100818.
- Hegedić, M., Gudlin, M., Golec, M., & Tošanović, N. (2024). Lean and Green Decision Model for Lean Tools Selection. *Sustainability*, 16(3), 1173.
- Januszek, S., Netland, T. H., & Furlan, A. (2024). The role of managerial perceptions and behaviors across hierarchical levels during lean implementation. *International Journal of Operations & Production Management*, 44(1), 54-74.
- Kumar, A. S., Babu, R. V., Parantharan, K. P., & Kumar, K. S. (2024, March). Lean implementation in manufacturing SMEs: A systematic review. In *AIP Conference Proceedings* (Vol. 2935, No. 1). AIP Publishing.
- Obasi, K. J. (2023). Manufacturing: The key to economic growth and shared prosperity in Nigeria. *Economic and Policy Review*, 21(1), 41-46.
- Ogar, O. J., Okoi, I. E., & Ite, O. F. (2024). The Impact of Manufacturing Output On Employment in Nigeria. *International Journal of Developing and Emerging Economies*, 12(2), 1-23.
- Shahin, M., Maghanaki, M., Hosseinzadeh, A., & Chen, F. F. (2024). Improving operations through a lean AI paradigm: A view to an AI-aided lean manufacturing via versatile convolutional neural network. *The International Journal of Advanced Manufacturing Technology*, 1-77.

- Singh, A., Kumar, V., Mittal, A., & Verma, P. (2024). Identifying critical challenges to lean construction adoption. *Construction Innovation*, 24(1), 67-105.
- Ullah, M. R., Molla, S., Mustaquim, S. M., Siddique, I. M., & Siddique, A. A. (2024). Exploratory approaches for improved cost effectiveness and profitability: Utilizing mathematical analysis and value stream mapping on production floors. *World journal of advanced engineering technology and sciences*, 11(1), 076-085.
- Vahidi, S., Mirhashemi, S. H., Noorbakhsh, M., & Molavi Taleghani, Y. (2018). Clinical errors: Implementing root cause analysis in an area health service. *International Journal of Healthcare Management*, 13(sup1), 256–267. <https://doi.org/10.1080/20479700.2018.1500771>
- Queiroz, G. A., Filho, A. G. A., Núñez, J. F., Santa-Eulalia, L. A., Delai, I., & Torkomian, A. L. V. (2024). Lean and Green Manufacturing in operations strategy: cases from the automotive industry. *Operations Management*