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LEAN MANUFACTURING PRACTICES AND FINANCIAL PERFORMANCE OF LISTED FMCG FIRMS IN NIGERIA

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Abstract: Due to a knowledge gap on how lean manufacturing practices by manufacturing firms translate to financial performance, this study was conducted to investigate how just-in-time production and raw material implementations affect financial performance in Nigeria. Accordingly, a regression analysis was performed to ascertain the effects of just-in-time production and raw material inventory implementation on financial performance. Financial performance was measured in terms of return on asset while labour productivity was employed as the moderator variable. Secondary data were collected from annual reports of the firms in the sample pool, following judgmental sampling of listed firm in the manufacturing sector of the Nigerian Stock Exchange. It was found that JIT production and JIT raw material inventory implementations respectively impact positively on financial performance as long as labour productivity is not controlled. But when labour productivity is controlled, JIT production failed to be significant at 5% level while JIT raw material inventory implementation remained significant at 1% level. Also, though labour productivity exerts positive impact on financial performance, there is rather a discordant interaction with JIT raw material implementation, contrary to the much touted synergistic interaction. We therefore conclude that labour intensity dominated manufacturing environment like Nigeria is ideal for the implementation of lean practices, among others. However, we recommend that managers should consider the systemic implications of implementing different lean practices, as these practices may exhibit incongruent interactions, among others.

Keywords: *Just-in time, Lean Manufacturing, Financial Performance, Nigeria*

1. INTRODUCTION

Lean manufacturing is popularly recognised as the benchmark of modern operations and supply chain management (e.g., Guinipero *et al*., 2005; Goldsby *et al*., 2006). Numerous researches have been conducted to evaluate the relationship between lean manufacturing and financial performance (e.g., Fullerton *et al*., 2003; Jayaram *et al*., 2008). However, the precise means by which lean manufacturing impacts financial performance of Nigerian manufacturing companies is still unknown. Conventional wisdom believes that, as a manufacturing strategy, lean manufacturing aims to reduce waste and hence boost efficiency (Womack *et al*., 1990), and thus financial performance.

Given the variety of lean manufacturing practices, such as kanban, *JIT*, and *TQM*, it is clear that the relationship between lean manufacturing and financial performance is complex and multi-faceted. In fact, one element that is always implicitly viewed as a mediator of this link is labour productivity. Several studies, for example, have looked at the effects of lean manufacturing adoption on labour productivity (e.g., Currence, 2018; Comm & Mathaisel, 2005). Furthermore, Fullerton and Wempe (2009) argue that the impacts of lean manufacturing implementation on financial performance are mediated by numerous operational performance variables such as delivery performance, manufacturing cycle lengths, and labour productivity. However, these scholars do not consider labour productivity to be a moderating factor.

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According to Currence (2018), lean philosophy as a strategic tool of production management works in many processes, particularly in labor-intensive processes where operators predominantly drive the cycle through the utilisation of low-intensity capital equipment. This is an appropriate environment for lean because, while humans exhibit more cycle-to-cycle fluctuation than machines, this variation occurs across a narrower range of time intervals (Hofer, Eroglu & Hofer, 2012). When the machine breaks down or goes into changeover, the cycle time can (and often does) become tremendous. When a cycle time is mostly human dependent, a human can increase the speed of a slower cycle to catch up. Most machines lack this intelligence. With humans possessing these key advantages over machine-based processes, they have the innate ability to wash out the effects of series-based statistical fluctuation (Currence, 2018). This is why lean works so well in highly manual, series-based processes. Delays occur at every stage of the system, from supplier sourcing to manufacturing to warehousing and transportation. When humans make the majority of the decisions in an environment where changeover impact is minor and breakdowns are nearly non-existent, lean is almost always the optimal strategy.

As a result, the goal of this study is to improve our understanding of lean manufacturing by investigating the relationship between lean manufacturing and financial performance, with a focus on the mediating role of labour productivity. Furthermore, and in keeping with the view that lean manufacturing is a system of lean practises (Womack et al., 1990), interactions between various aspects of lean manufacturing and their impacts on labour productivity and performance are explored. It is important to note that as a moderator, labour productivity plays dual role since it can be regarded equally as a product of lean practice from the perspective of continuous improvement (i.e. *TQM*) as a form of lean philosophy.

This study adds to the existing literature in several ways: First, it provides a more detailed, in-depth knowledge of the linkages between lean manufacturing, labour productivity, and financial performance. We specifically draw on current lean manufacturing and labour productivity literature to construct a study model that investigates the role of labour productivity in providing the frequently expected financial performance gains of lean manufacturing implementation. This model is validated using a data set containing firm-level observations from a broad group of Nigerian manufacturing firms. We go beyond traditional mediation research to look for potential reverse causality and acquire a deeper understanding of the relationship between lean manufacturing, labour productivity, and financial performance.

Second, this research looks at the interactions between lean practises. Existing literature implies that when lean practises are applied concurrently, the cumulative performance effect will outweigh the sum of individual lean practise performance effects (Shah & Ward, 2003). While several researches (for example, Furlan *et al*., 2011a) empirically examined the complementarity (synergy) of lean practise bundles, these analyses were limited to certain components of lean production and focused on plant-level performance. We conceptualise lean manufacturing as two lean practise bundles (inflow and outflow) in this study, and we investigate the synergy between these lean practise bundles at the firm level rather than the plant level.

Third, the study's two key constructs, *JIT* production implementation and *JIT* raw material implementation, are operationalized in tandem with the Toyota Production System's principle-based definition of waste (overproduction and excess inventory). These notions have been reaffirmed in the operations research literature as critical to firms' profit maximisation goals. As such, the study contributes to the literature on operations management by providing independent empirical proof for the validity of these assumptions.

Fourthly, this study attempts to provide a scientifically verifiable explanation of possible negative impact of internal lean practice on inventory leanness which was observed by Hofer, Eroglu and Hofer (2012) in their study but who were attributing their observation to a freak of statistical measurement glitch. This study improves on the trio's by making use of longitudinal data and so, produces a more reliable and valid estimate of the relationship between lean manufacturing and financial

performance. We conjecture a significant moderating role of internal lean practice such as labour productivity in the relationship between input and output factor of lean manufacturing practice dynamics.

Lastly, the Nigerian manufacturing industry is implicitly suggested to be apathetic to lean philosophy and practice resulting in their sub-optimal performance (Ariguzo, Amos, Egwakhe & Adefulu, 2019; and Inuwa & Usman, 2022). The veracity of this conjecture has not been satisfactorily ascertained because empirical literature on lean manufacturing and financial performance in Nigerian context is scarce. Besides, the few available Nigerian literatures on lean manufacturing fail to provide insight on degree of lean practice prevalence in Nigeria. In fact, apart from a few studies (e.g. Tarurhor & Emudainohwo, 2020; Udeze, Ugbam & Ugwu, 2018 and Ariguzo, *et al* 2019) on the subject-matter, no other study on the nexus between lean manufacturing and performance exists to the best of the authors' knowledge. These studies are severely plagued by myriads of methodological limitations such as sampling inadequacy and bias, narrow population and geographic scope, measurement deficiency, and high probability of their data collection methods being biased. As a result, the resulting inferences from these studies lack reliability and validity, thus necessitating a new empirical inquiry. In this study, using secondary data, we seek potential reverse causality and gain a better understanding of the relationship between JIT production implementation, JIT inventory implementation, labour productivity, and financial performance.

The remainder of this paper is structured as follows: The relevant literature is reviewed and hypotheses are proposed in Section 2. Data and measurement issues are discussed in Section 3. In Section 4, mediation and interaction hypotheses are tested and empirical estimation results are presented and discussed. Section 5 presents conclusion, implications, limitations, and future research opportunities.

2. LITERATURE REVIEW

2.1 Conceptual Framework

Lean manufacturing is a production method that focuses on minimising time within the production system as well as reaction times from suppliers and customers. It is closely related to another term known as Just-In-Time Manufacturing (Hofer, Eroglu, & Hofer, 2012). Just-in-time manufacturing attempts to match production to demand, by only supplying goods that have been ordered, and to match input materials procurement to consumption by taking delivery of exact production demand (Hofer, Eroglu, & Hofer, 2012). Lean manufacturing also entails quality, attained through process of continuous improvements over time. The philosophy of process improvement involves major input factors such as inventory, labour, machine hours and finance, and elimination of waste completely from the process (Ariguzo et al., 2019). Waste as classified by Lareau (2003) involves people (human elements in a strategic drift from the firms' goals).

Accordingly in the current study, we represent lean manufacturing in terms of *JIT* production and *JIT* raw material inventory, and use labour-productivity as moderator variable. Figure-1 represents the conceptual framework of the study.

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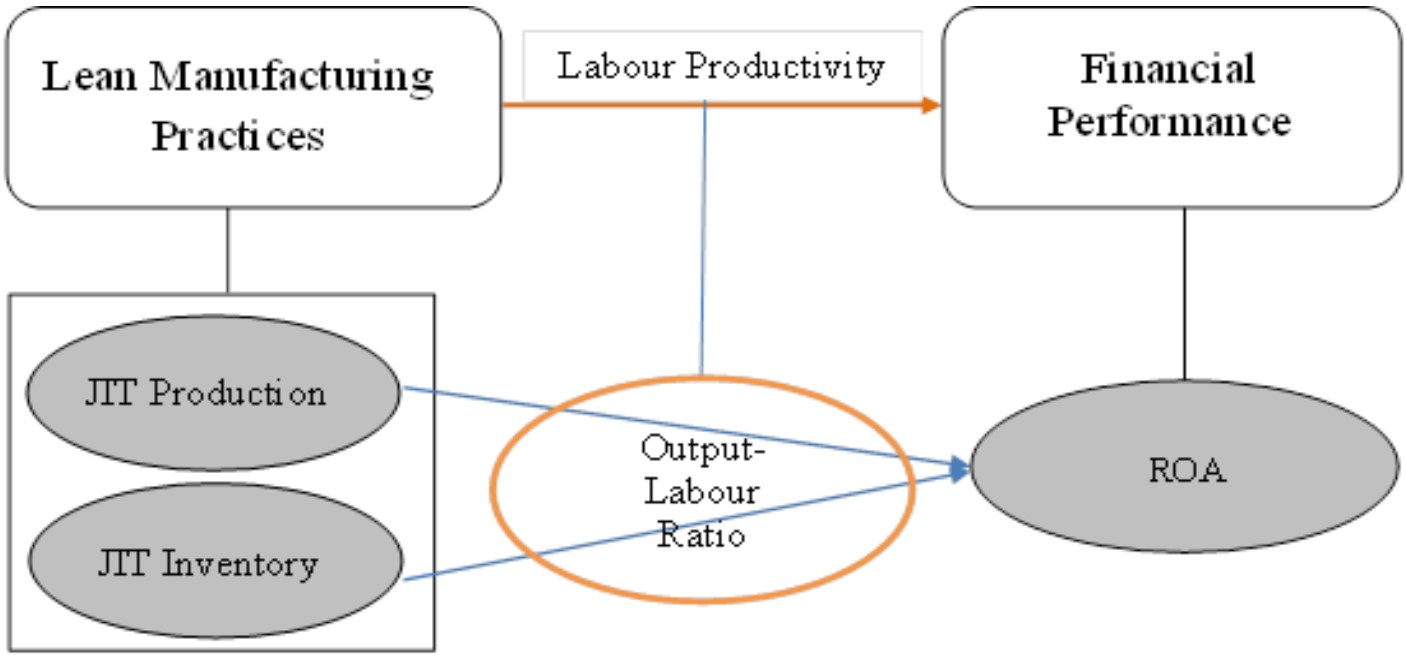

Figure-1: Operational Framework for the study

JIT Production as a construct therefore embodies the degree to which an entity's output process complies with lean principle of matching production to sales order for its products, while JIT Inventory signifies the degree to which an entity's input process conform to lean principle of matching input materials procurement to production requirement. According to Sumanth (1997), productivity measures that use one class of inputs or factors, but not multiple factors, are called partial productivities. At the company level, typical partial productivity measures are such things as worker hours, materials or energy used per unit of production (Sumanth, 1997). Accordingly in the context of this study, labour productivity characterises the degree to which an entity achieves value-added per naira cost of labour used.

Thus fig-1 lucidly illustrates the study's overall framework as one in which financial performance (measured by return on equity) is conjectured to being influenced by two dimensions of lean manufacturing practices (*JIT* Production and *JIT* Inventory), subject to moderation by labour-productivity.

2.2 Theoretical Background

The resource-based view of the firm (RBV) theoretically underpins the nexus between lean manufacturing and financial performance. Wernerfelt (1984) proposed the RBV in the literature, which is based on the premise that a firm's financial success is largely controlled by the resources it owns and controls. Typically, resources are classified as assets or capabilities. The firm owns and controls assets that can be tangible or intangible (Collis, 1994). Intangible bundles of skills and acquired knowledge exerted through organisational routines are defined as capabilities (Nelson & Winter, 1982; Teece et al., 1997). According to the research, firm resources can only be key factors of long-term competitive advantage and improved firm performance if they have specific features (Barney, 1991). That is, the RBV's main prescription holds that only resources that are valuable, rare, inimitable and non-substitutable are capable of generating and sustaining competitive advantage which affords the accrual of superior financial performance. Such resources are considered to be strategic, intangible

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resources (Amit & Schoemaker, 1993; Michalisin et al., 1997). Lean manufacturing capability is one of such intangible resources due to its association with operational efficiency and customers' satisfaction focus, among other value-enhancing attributes in the organisation's supply-chain. Therefore, based on the RBV theory, the *a priori* expectation following from figure-1 is a positive relationship between lean manufacturing and financial performance. Meaning that all things being equal, greater degree of *JIT* Production by an entity is expected to elicit higher return on equity for the entity, and vice versa. Likewise, greater degree of *JIT* Inventory by an entity is expected to result in higher return on equity for the entity, and vice versa.

2.3 Empirical Review

The conjecture, that lean manufacturing practices exert positive influences on financial performance, though can easily be substantiated theoretically, have mixed results in empirical literature. Scholarly insight into manufacturing firms in Nigeria by Ariguzo *et al* (2019) indicated that lean manufacturing (labour productivity, time efficiency, and quality output) has a strong influence on profitability. The study assessed lean manufacturing system adoption ability to stimulate profitability, within Nigerian food and beverage sub-sector. Emphasis was placed on waste reduction, labour optimization and inventory control to firms' profit before tax. The comparative approach emerged from *ex-post-facto* design pillared on quantitative data from three top players in Nigeria, pre- and post-implementation of the lean process. The study found lean manufacturing to have significantly affected the profitability in Nestle and Cadbury Plc, but observed no changes in Unilever.

Okpala (2013) also observed lean manufacturing from the six sigma methodologies against profitability from manufacturing small and medium enterprises in Nigeria, and found that it had no influence on profit levels. This observation was attributed to unwilling leadership support, followers' buy-in, and poor documentation of the lean success evidences. The divergence observed from Okpala's study (2013) was previously established by Panizzolo *et al* (2012) with evidence from Indian SMEs which discovered that lean manufacturing system did not affect profitability due to restrictions that dwelt on culture, skills and knowledge gaps, and top management lack of commitment.

Tarurhor and Emudainohwo (2020) examined the effects of lean manufacturing practices on a firm's performance, considering lean culture as a moderating variable in Delta state's palm oil industries. The study's sample was palm oil industries located in Delta state, Nigeria. Data were gathered through a survey of four hundred and thirty-three (433), and two hundred and four (204) were used to test the hypothesis. The study used the structural equation model to analyze the quantitative data generated from the four points Likert scale questionnaire. The authors found that lean manufacturing proxied by empowerment, training, and development has a positive and statistically significant effect on a firm's performance in terms of product quality. Results proved that the lean culture had a negative impact on a firm's performance.

On the contrary, Udeze, Ugbam and Ugwu (2018) investigated the effect of Lean Manufacturing on performance in the Nigerian manufacturing sector. The population of the study was 2,703 employees of the selected manufacturing organizations; a sample size of 336 was obtained using Godden (2004) statistical formula for determining sample size for finite population. Out of the 336 copies of the questionnaire distributed, 326 copies were returned and used for analysis. Pearson Product-Moment Correlation Coefficient and linear regression analysis were used for the analyses. It was found that there was a positive correlation between leanness and organizational.

Thus far, available empirical literatures of Nigerian origin explore the direct effects of lean manufacturing practices on financial performance. Most of these studies employ a survey methodology to assess the degree of implementation of lean manufacturing practices and to measure financial performance. The measures of lean manufacturing are typically narrowly limited to individual or plant, rather than company-wide application. Other studies identify companies that have adopted *JIT* practices possibly via a search of news articles and company reports which may undermine the study for firms whose records are mostly inaccessible for

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research purpose. The studies' findings are largely inconsistent, as evidence of positive effects of lean manufacturing implementation on at least some financial performance indicators is presented, while in some others, statistically significant relationship was not found between lean manufacturing practices and firm profitability. These shortcomings observed from the foregoing empirical literature therefore underscore the gap in literature against which backdrop the current study is undertaken to fill.

2.4 Hypotheses Development

2.4.1 JIT Inventory and Financial Performance

Contrary to dearth of rich literatures of Nigerian origin, those of foreign origin offer diverse cocktail of rich perspective on the subject-matter. There is a large body of conceptual and analytical literature that discusses the profit implications of inventories (e.g., Relph & Barrar, 2003; Chika´n, 2011). Empirical studies in this stream of research use large cross-sectional time series data sets compiled from secondary databases to explore the link between inventory metrics and financial outcomes. Chen *et al*. (2005, 2007) find that firms with inventory levels below industry average tend to have greater stock returns. Similarly, Eroglu and Hofer (2011) find that firms whose inventory levels are (slightly) below size-adjusted industry averages tend to exhibit greater financial performance. Swamidass (2007), Koumanakos (2008) and Capkun *et al*. (2009) also present evidence of a negative relationship between inventory levels and profitability. Cannon (2008), however, finds no significant relationship between inventory turnover and financial performance. Thus besides Cannon's (2008) study which found no significant relationship, the findings of the other stream of literature are all in tandem with the conjecture of positive relationship between lean inventory practice and financial performance. In line with the majority of literature being in support of positive effect of lean inventory on financial performance, we propose to interrogate the following hypothesis:

H_{01} *JIT Inventory practice of manufacturing firms in Nigeria does not exert*

significant positive impact on their financial performance

2.4.2 JIT Production and Financial Performance

Obtainable literature details the impact of specific features of lean manufacturing on financial performance as well as other operational performance parameters. The basic logic is that operational gains associated with lean manufacturing, such as lower inventory, higher quality, and less waste, eventually lead to superior financial performance. Mistry (2005) and Fullerton and Wempe (2009) investigate the relationship between lean manufacturing, operational outcomes, and financial performance. Mistry (2005) identified many pathways by which JIT practises influenced various operational outcomes and, ultimately, boosted profitability based on a case study of an electronics factory that had previously implemented selected JIT processes. Furthermore, Mistry (2005) discovered anecdotal evidence that the introduction of assemble-to-order manufacturing systems contributes to cost reductions through reduced work-in-process and raw materials inventory requirements. Thus, it is hypothesized that:

H_{02} *JIT Production practice of manufacturing firms in Nigeria does not exert significant positive impact on their financial performance*

2.4.3 Mediating Role of Labour-Productivity

In companies where the traditional hierarchy has been removed in favor of an egalitarian, team-based setup, the employees are often happier, and individual productivity is improved (as they themselves are better placed to increase the efficiency of the shop-floor). This increased productivity enhances lean manufacturing implementation on one hand, and ultimately also leads to better financial performance. Fullerton and Wempe (2009) conducted a survey study and found evidence that non-financial manufacturing performance measures, such as labor productivity, mediate the relationship between lean manufacturing implementation and *ROA*.

In lean manufacturing settings, where excess inventory or other buffers are not available to counter production or quality failures, employees must have the ability and authority to make decisions. Badore (1992) describes shop-floor employees' unique understandings of their work environments as an important element of such decisions. Koufteros *et al*. (1998) characterize employee

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involvement as an antecedent to adoption of time-based manufacturing methods, and Boyer (1996) finds that companies committed to lean manufacturing devote resources to train and empower their workforces.

However, prior researchers on the mediating role of labour productivity in the nexus between lean manufacturing and financial performance often ignore the opportunity cost of lean practice from the perspective of labour productivity. When labour is highly productive, high opportunity cost is often incurred in terms of idle labour time in between sales orders. This is especially so since sales forecast inaccuracy is an inherent factor of every business. The cumulative opportunity costs from such idle time in between sales order could outweigh the economic benefits obtainable from leanness, such that a negative relationship could exist between lean manufacturing and financial performance. Given this possibility, it is uncertain which of these two is prevalent in Nigerian context. However, irrespective of whichever is prevalent, what is contentious is the significance of such moderating impact if at all any exists. Consequently, we propose the following hypothesis for inferential analysis:

H_{03} The effect of lean manufacturing practices of Nigerian firms on their financial performance is not moderated by firm-specific labour productivity rates

3. METHODOLOGY

3.1 Study Design

This study employed the usage of an ex-post-facto research design which was deemed appropriate because it entails the collection of data from secondary sources over a period of time, in order to establish the relationship and effect existing among the variables of interest. To test the hypotheses set forth in this study, a panel data set composed of secondary financial data was utilized to measure the degree of a firm's implementation of *JIT* inventory, *JIT* production, labour productivity and financial performance. The use of exclusive secondary data sources is intended to address the issue of subjectivity often associated with primary data methodology. The population of the study is Listed FMCG firms in Nigeria whose shares were actively traded on the floor of the Nigerian Stock Exchange during the study period scope covering from January 2013 up to 31st December 2022. Since the population is small and finite, a census technique of sampling is adopted but subject to the criteria against data survivorship bias.

3.2 Variables Operationalisation

Following in the footsteps of Hofer *et al* (2012) who aptly characterised *JIT* (Just-in-time) philosophy as an attempt to match supply to demand (i.e. production to demand, and raw materials procurement to consumption), ***JIT production*** is operationalized as:

$$JPROD = 1 - \frac{|\Delta FG\ Inv|}{COGS}$$

Where *COGS* is Cost of goods sold; and $|\Delta FG\ Inv|$ is the absolute difference between closing and opening balances of finished goods inventory. The greater $|\Delta FG\ Inv|$ gets, the less manifestation of ***JIT Production*** in the firm becomes, and vice versa. In fact the value *JPROD* takes ranges between 0 and 1; the closer the coefficient gets to 1, the greater the manifestation of *JPROD*.

In the same token, ***JIT inventory*** is operationalized as:

$$JINV = 1 - \frac{|\Delta RM\ Inv|}{RMC}$$

Where *RMC* is cost of raw materials used and $|\Delta RM\ Inv|$ is the absolute difference between closing and opening balances of raw materials inventory. Similarly, the closer the coefficient (*JINV)* gets to 1, the greater the manifestation of *JINV*.

On the other hand, financial performance is operationally defined as return on equity (ROA):

$$ROA = \frac{PAT}{Total}$$

Where *PAT* = Profit-After-Tax and total asset is at net book value. Our choice of this measure is based on the ease of accessing cross-validation finding since it is the most popular measure in empirical literatures.

Finally, labour productivity is operationalized as value-added per naira personnel cost (also known as value-added to labor cost ratio):

$$LPROD = \frac{Value\ Added}{Personnel\ Cost}$$

Where Value-added is obtained as total revenue minus bought-in goods and services of firms. The ratio is essentially a reciprocal of employees' share of value-

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added in the traditional statement of value-added which is usually prepared along with other annual corporate financial report components. A high ratio indicates that the enterprise is highly efficient in terms of labor productivity (Mandal & Goswami, 2008).

The denominator of the ratio of labour productivity, the input measure is the most important factor that influences the measure of labour productivity. According to Freeman (2008), labour input is measured either by the total number of hours worked of all persons employed or total employment (head count). There are both advantages and disadvantages associated with the different input measures that are used in the calculation of labour productivity. It is generally accepted that the total number of hours worked is the most appropriate measure of labour input because a simple headcount of employed persons can hide changes in average hours worked and has difficulties accounting for variations in work such as a part-time contract, paid leave, overtime, or shifts in normal hours. But since the components are all drawn from accounting records, we can still express labour productivity in financial terms without compromising the intended measure, as suggested by Mandal and Goswami (2008). Therefore, the authors adopted the view that supports financial measure.

3.3 Model Specification

Going by the objective of the study which is to investigate how much influence, if any, lean manufacturing practices of listed FMCG firms in Nigeria exerts on their financial performance, the most appropriate tool of analysis of our hypotheses is multiple regression technique. In simple empirical form, our model for the study is therefore stated as follows:

$$ROA_{it} = \beta_0 + \beta_1 JINV_{it} + \beta_2 JPROD_{it} + \beta_3 LPROD_{it} + U$$

where we expect β_1, β_1, $\beta_1 > 1$ as predicted by the resource based view theory.

4. RESULT

4.1 Descriptive Analysis

Descriptive statistics of the study variables are presented in table-1. Firstly, the measures of central tendencies (mean and median) indicate considerably high prevalence of lean manufacturing practices among the sampled firms in Nigeria; contrary to the widely held believe that Nigerian firms do not practice lean manufacturing. However, the data distribution for each of the variables is skewed negatively, indicating that there is no symmetry in the distribution. For each of the variable, the shape of the curve is tilted towards the left with a long tail on the left side, with the median values respectively greater than the mean values. It shows the volatile nature of lean manufacturing practice in the Nigerian manufacturing industry as the majority of data points are concentrated on the right side, with a few extreme values dragging the distribution to the left. More specifically, the standard deviations show that just-in-time raw material practice is more volatile than that of production. This is in line with expectation because production decision is easier to control since it is purely internal factor, than decision on matching raw material supply to raw material requirement for production; the latter being largely depends on external factor. Distributions of just-in-time raw material practice (*JINV*) and return on assets (*ROA*) have lower than normal kurtosis value, indicating that their distributions have lighter tails than the normal distribution.

Table 1: Descriptive Statistics

	JINV	JPROD	LPROD	ROA
Mean	0.808091	0.964232	1.851610	0.099874
Median	0.843880	0.978183	1.961943	0.106520
Maximum	0.992000	0.999916	2.820394	0.196884
Minimum	0.443524	0.781338	1.003896	-0.025319
Std. Dev.	0.141136	0.041418	0.514582	0.049997

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Skewness	-0.689959	-2.133751	-0.085964	-0.200977
Kurtosis	2.569937	8.194607	1.845354	2.403924
Jarque-Bera	6.267379	135.5865	4.088297	1.550622
Probability	0.043557	0.000000	0.129490	0.460561
Observations	72	72	72	72

On the other hand, labour productivity (*LPROD*) and just-in-time production practice (*JRPOD*) have higher than normal kurtosis, indicating that they have heavier tails and a more peaked distribution. The Jarque-Bera (JB-stat) and their associated probability values affirm the non-normality of the respective data distributions of the *just-in-time* variables while those of ROA and labour productivity affirm normality of their data distribution. Thus in a nutshell, descriptive analyses show that there is a considerable degree of lean manufacturing practices manifestation in the Nigerian manufacturing industry. However, this practice is not wide spread but rather skewed in certain direction that suggests that it is not as deep-seated as it is in industralised climes.

4.2 Bivariate Analysis

A cursory correlational analysis as presented in table-2 shows that there are significantly high relationships among the study variables.

Table- 2: Correlation Matrix of Financial Performance and Lean Manufacturing

	LPROD	***JPROD***	***JINV***	***ROA***
LPROD	1			
	-			
	72			
JPROD	0.3605	1		
	0.0028	-		
	72	72		
JINV	0.3674	0.6330	1	
	0.0023	0.0000	-	
	72	72	72	
ROA	0.9340	0.4642	0.4818	1
	0.0000	0.0001	0.0000	-
	72	72	72	72

While the high relationships between the dependent variable (*ROA*) and the independent variables (*JINV* and *JPROD*) are confirmations of the causal relationship that exist between them, that of independent-to-independent is an indication of statistical anomaly known as multicollinearity. In ordinary least square (OLS) regression analysis, multicollinearity exists when two or more of the independent variables demonstrate a linear relationship between them. With multicollinearity, the regression coefficients are still consistent but are no longer reliable since the standard errors are inflated.

Variance Inflation Factor (VIF) is commonly used tool to detect whether multicollinearity exists in a regression model. When VIF or tolerance is equal to 1, the independent variable concerned is not correlated to the remaining ones, which means multicollinearity does not exist in this regression model. Generally, a VIF above 4 or tolerance below 0.25 indicates that multicollinearity might exist, and further investigation is required. When VIF is higher than 10 or tolerance is lower than 0.1, there is significant multicollinearity that needs to be corrected.

Table-3: Multicollinearity Test

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Var	R-Sqr	Tolerance	VIF
JPROD	0.4007	0.5993	1.6686
JINV	0.4007	0.5993	1.6686

In the instance of *JINV* versus *JPROD* alone as reported in table-3, there is no need for serious concern about multicollinearity since the VIF is 1.6686. However, beyond including more than the two independent variables, it might give rise to worrisome VIF.

4.3 Test of Hypotheses

4.3.1 Test of Hypotheses (H_{01} and H_{02})

The objective here is to fit the transformed data to the specified model in section 3.3 exclusive of the contextual factor. Normally as a panel data analysis, further analyses (such as Hausman test) are required to determine how best to handle idiosyncratic firm-specific heterogeneity (e.g. dissimilarities in product line, organizational culture, production techniques, etc.). However, we assume that such heterogeneity if present is mild since the subject matter of inquiry is of generic nature that is unlikely to be susceptible to heterogeneity interferences. Following from our assumption therefore, pooled regression methodology is used and the result is presented in table-4. Table 4 shows that the model is significant (F = 13.0472; Sig F = 0.000). The model also approximately explained 25.3% (i.e. adjusted R^2= 0.253) of the variation in the financial performance characteristics of the firms that make up the sample pool. There is no autocorrelation as the Durbin-Watson statistic is within the expected range, meaning that the estimated coefficient can be relied upon.

Table-4: Regression Result of ROA and Lean Manufacturing

	Coeff.	*Std Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.299	0.134	-2.240	0.028	-0.565	-0.033
JPROD	0.321	0.160	2.005	0.049	0.002	0.640
JINV	0.111	0.047	2.368	0.021	0.017	0.205

Multiple R	0.5238	Standard Error	0.0432
R Square	0.2744	Durbin-Watson	2.0218
Adjusted R Square	0.2534	F-Statistic	13.0472
Observations	72	Prob (F)	0.0000

Both *JPROD* and *JINV* are significant and positive. With *JPROD* being 0.321, it implies that *ROA* is expected to rise by 0.321 for every 1 unit increase in *JPROD*. Likewise, for every 1 unit increase in *JINV*, *ROA* is expected to increase by 0.111. Therefore with respect to H_{01}, since the prob. (value) is 0.021 which is < 0.05, there is sufficient statistical justification to reject H_{01}, hence; *JIT Inventory practice of manufacturing firms in Nigeria exerts significant positive impact on their financial performance*.

In similar manner with respect to H_{02}, since the p-value of the coefficient for *JPROD* is 0.047 which is less than the significance alpha level (i.e. 0.05), we reject H_{02}. Hence we conclude that *JIT Production practice of manufacturing firms in Nigeria exerts significant positive impact on their financial performance*.

4.3.2 Test of Hypothesis (H_{03})

In this subsection, we need to construct a moderated regression model by including the contextual factor in the model, as well as the interaction terms to capture the interactions between labour productivity (*LPROD*) and the main independent variables:

$$ROA_{it} = \beta_0 + \beta_1 JINV_{it} + \beta_2 JPROD_{it} + \beta_3 LPROD_{it} + \beta_4 LPROD_{it} * JINV_{it} + \beta_5 LPROD_{it} * JPROD_{it} + e$$

The result is presented in table-5.

Again, the model is significant as reported in table-5. The *F*-statistic (145.510) is significant at 1% level, indicating a good linear fit, just as the Durbin-Watson statistic (1.319) indicates negligible presence of autocorrelation. Together, the independent variables along with the interaction terms were able to achieve 91.1% capability of

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predicting *ROA*. The coefficients of just-in-time raw material inventory (*JINV*) and labour productivity (*LPROD*) are significant at 1% level. Of the two interaction terms, only the interaction between *JINV* and *LPROD* is significant at 5% level. *JPROD* and its interaction with *LPROD* failed to cross the 5% significance threshold when the moderating effect of *LPROD* is controlled.

Table-5: Moderated Regression Result of ROA and Lean Manufacturing

	Coef	***Std Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	-0.593	0.215	-2.762	0.007	-1.022	-0.164
JPROD	0.409	0.249	1.645	0.105	-0.087	0.906
JINV	0.173	0.063	2.738	0.008	0.047	0.299
LPROD	0.379	0.138	2.736	0.008	0.102	0.655
JPROD*LPROD	-0.238	0.156	-1.531	0.131	-0.549	0.072
JINV*LPROD	-0.076	0.035	-2.189	0.032	-0.146	-0.007

Multiple R	0.958	Standard Error	0.015
R Square	0.917	Durbin-Watson	1.319
Adjusted R Square	0.911	F-Statistic	145.510
Observations	72	Prob (F)	0.000

Thus in line with the results of the fitted moderated equation of *ROA*, *ROA* response coefficient of *JINV* alone is significant, and is ascertained to be as follows:

*(0.173 – 0.076*LPROD)*

The *ROA* response coefficient of JINV can therefore be interpreted to mean that for as long as employee productivity (*LPROD)* remains less than or equal to 2.276 (i.e. = 0.173÷0.076) value-added per naira benefits earned, the observed positive relationship between *JINV* and *ROA* will continue to hold true. In other words, firms where average productivity exceeds the said threshold, just-in-time raw material inventory management will associate negatively with *ROA*. This can be explained to imply that, likely loss of productivity in between sales order is higher than the benefits of *just-in-time* inventory system. Thus the obtained result confirms labour productivity as a possible moderating factor in evaluating the relationship between lean manufacturing and financial performance. The basis of moderation in this case, is likely prohibitive cost of idle time in between sales order, especially in firms where employees possess high productivity. However, firms where employees do not have much productive staff, *just-in-time* raw material management is likely to associate positively with financial performance. Therefore with respect to H_{03}, there is sufficient statistical reason to support the rejection of the hypothesis.

4.4 Discussion of Findings

It is conclusive empirically that the current study has produced results that uphold the resource-based view. For manufacturing firms in Nigeria where lean manufacturing is practiced, lean manufacturing capability is an intangible resource. It is no doubt, associated with operational efficiency and other value-enhancing attributes in the firms' supply-chain. Firms where inventories are built up are exposed to inefficiencies because such inventories that are tied down attract opportunity costs in the form of lost opportunity to earn interest income on such tied down funds. For such firms, the costs arising from losing interest yielding opportunity outweigh the benefits of carrying the inventories. Our result thus supports the results of Mistry (2005) and Fullerton and Wempe (2009) who investigated the relationship between lean manufacturing, operational outcomes, and financial performance and found positive and significant relationship.

With respect to the moderating effect of labour productivity, prior literatures have identified imperativeness of employees' participation as precursor to time-based manufacturing methods (e.g. Koufteros *et al*., 1998); necessity of employee training and

empowerment as prerequisite to lean manufacturing implementation (Badore, 1992). The current study has produced empirical evidence in support of these assertions, but with a critical caveat attached. One essentially defining feature of *just-in-time* practice is operational activity that is driven by sales order. In between sales orders, a very efficiently productive employee is likely to complete task well in time and remain idle. For such an efficient and productive employee, the opportunity cost of that kind of idle time could be very high, enough to overturn the cost-savings from inventory carrying cost. Thus the current study has produced a novel idea that is backed up with empirical evidence in shedding light on negative relationship between lean manufacturing and financial performance.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

We examined lean manufacturing by zeroing in on two aspects of just-in-time practices of listed manufacturing firms in Nigeria and have made some remarkable findings. To begin with, this study has produced empirical evidence that debunks the popular notion of apathetic disposition of Nigerian manufacturing firms to lean manufacturing practice. In actual fact, the craft is widely practiced without being keenly aware by many. Secondly, in line with our *a priori* expectation, labour intensity dominated production environment like Nigeria should be ideal for lean manufacturing practice. Our study has unambiguously affirmed this conjecture. It might not be an exaggeration to speculate that human's predisposition for self-initiative to make-up for lost man-hours exerts strong pull effect on firms' inclination towards lean manufacturing practice. Thirdly, although this study also produced evidence that confirms external supply-chain as being more critical than those of internal production mechanisms do in lean manufacturing context, the fact that the two combined together yields positive impact on financial performance is evident enough on their complementarity. In this study, we conceptualised lean manufacturing as two lean practise bundles (inflow and outflow), and our investigation has shown the synergy between these lean practise bundles at the firm level. Lastly but not by any means the least, is the finding that follow from the interaction between lean practice and labour productivity, which suggests that lean manufacturing practice is not ideal where labour productivity is high. Due to uncertainty and consequent sales forecast inaccuracies, idle time in between sales order is inevitable. Our study's finding suggests that for a highly productive labour, such idle time can be more expensive than the benefits of leanness, depending on the average time interval in between sales orders.

This study has implication for practice as well as for future research. With regards to practice, this study highlights the significance of examining lean manufacturing within the operational framework of an organisation. The findings of this study indicate that the introduction of just-in-time raw materials has a significant impact on financial performance, which is mediated by labour productivity. The variation in labour productivity among industries and enterprises suggests that the financial impacts of implementing *just-in-time* raw materials may also vary proportionately. One intriguing conclusion of this research for managers is to the adverse interaction effect of *just-in-time* (JIT) raw material practises. Put simply, the adoption of a specific lean practise not only yields direct performance advantages, but it can also have adverse effects on the effectiveness of other pre-existing lean practises inside an organisation. Managers should consider the systemic implications of implementing different lean practises, as these practises may exhibit incongruent interactions. Moreover, it is imperative to evaluate the interplay of different practises in order to ascertain the overall impact on performance resulting from a certain lean practise. Additionally, our study emphasises the significance of taking into account operational performance outcomes, such as labour productivity, as a preliminary factor for improved financial performance.

With respect to future research, although we used longitudinal data, there might be some chance that data containing a longer period could have been more apt for a study of this nature. There exists a feasible scenario wherein enterprises gradually enhance their proficiency in the implementation of lean practises, perhaps leading to improved financial performance. This topic could be

further investigated in future studies through the examination of the long-term effects of lean practises. Furthermore, future studies might want to consider the inclusion of qualitative aspects of lean practices as we only focused on quantitative aspects of the subject.

5.2 Recommendation

In line with the outcome of the study, we recommend as follows:

1. Managers should consider the systemic implications of implementing different lean practises, as these practises may exhibit incongruent interactions.
2. Managers should evaluate the interplay of different practises in order to ascertain the overall impact on performance resulting from a certain lean practise.
3. Business owners who practice lean manufacturing are advised to maintain fairly diversified product portfolios in order to reduce the cost of idle-time that may arise from in-between sales orders.

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