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LEAN PRODUCTION AND OPERATIONAL PERFORMANCE OF MANUFACTURING FIRMS IN RIVERS STATE

[1]Ofoegbu, Wilson Chukwuemeka & [2]Efeh, Valentine Omorse
[1, 2] Faculty of Management Sciences,University of Port Harcourt, Nigeria
[1]wilson.ofoegbu@uniport.edu.ng [2]efehvalentine@gmail.com
[1]08068753432 [2]08036628707

Corresponding author: *Ofoegbu, Wilson Chukwuemeka
Email: wilson.ofoegbu@uniport.edu.ng

A B S T R A C T

This study examined the relationship between lean production and the operational performance of manufacturing firms in Rivers State. The population involved all the sixty-two (62) manufacturing firms in Rivers State with a sample size of four (4) selected manufacturing firms using the Krejcie and Morgan sample size determination and simple proportion to arrive at the respondents for each Manufacturing firm. Data were collected using a structured questionnaire and interview protocol. Structural Equation Modelling (SEM) with the aid of the Analysis of Moment Structure (AMOS) was chosen to test the hypothetical model while the qualitative data was organised, coded, and analysed using the NVivo 11. The result showed that there is a significant and positive relationship between lean production and the operational performance of manufacturing firms in Rivers State. Therefore, concluded that lean production is a critical and highly imperative factor in sustaining business operations and performance and thus recommended that management of the manufacturing firms should develop procedures and policies to which employees will adhere and ensure routine checks on equipment and service processes.

K E Y W O R D S:

lean production, operational performance

INTRODUCTION

In recent years, many production and service companies have been challenged to increase their focus on quality of products and customer satisfaction; putting into consideration the challenges of global competition by finding ways of reducing costs, improving quality and meeting the everchanging needs of customers.

These challenges are evident in one of the major problems faced bymanufacturing sector in Nigeria which is lack of operational performance (Margono& Sharma, 2006; Margono*et al*., 2011). It is one of the central objectives of a production system (Gupta, Acharya, & Patwardhan, 2013; Holweg, 2007).Operational performance is related to organization's internal operation such as productivity, quality of product and customer satisfaction (Feng *et al*., 2007; Nugraha&Indrawati, 2017; Kuo& Chen, 2015). It is typically assessed along with the dimension of percent returns (Rosenzweig *et al*., 2003; Poirier & Quinn, 2004), percent defects (Frohlich & Westbrook, 2001), delivery speed (Buzzell&Ortmeyer, 1995), production costs, production lead time, inventory turnover and flexibility (Zhu &Karemer, 2002; Ranganathan *et al*., 2004).

Achieving operationalperformance may require several changes in organizational operations such as methods and procedures. Lean production has a role to play here as it is addressed to eliminate non-value-added activities; and at the same time, maximize utilization of value-added activities (Abdel-Razek, Elshakour, & Abdel-Hamid, 2007; Gupta *et al*., 2013). Hence, Lean production potentially has an impact on the way in which firms combine resources and activities to enhance operationalperformance(Chavez, Gimenez, Fynes, Wiengarten, & Yu, 2013; Chen & Tan, 2013; Dal Pont *et al*., 2008; Khanchanapong*et al*., 2014; Rahman *et al*., 2010; Singh, Garg, Sharma, & Grewal, 2010b).

The practice of lean originated from Toyota that used names such as "Just-in-Time" Production or Toyota production system (TPS) in the 1950s. the main goal of TPS was to reduce costs and improve efficiency by eliminating wastes or non-value adding activities (Womack et al., 1991).Lean Production is a new step in production that combines the advantages of mass production and manual production. Lean Production principles include: eliminating wastes, zero defects, multi-dimensional teams, and reduction of organizational layers, team leadership, and vertical information systems, continuous improvement and pull systems. This method is based on systems including workers with several skills, automatic and flexible machines. In this method, the organization management tries to remove production space, equipment investment, engineering work hours and stagnant inventory and pays attention to zero defect and zero inventory. In lean Production, the producers try to achieve advantages and avoid disadvantages in manual and mass production. They have measures that reduce products cost and produce the products that the customers need using skilled staff in all organizational levels and multi-dimensional machineries with capability of producing various products (Jafarnejad, 2012).

Lean production aims to have better functions for stakeholders (Azevedo, Govindan, Carvalho, & Cruz-Machado 2012). In England, less than ten percent of the firms succeeded in using lean production methods (Bicheno&Holweg, 2009). Although, the advantages of lean production are not always obvious but now, the methods and tools of lean production have been considered by producers compared with traditional methods (Poya&Soltani, 2015). Indeed, lean production is an exponential jump from Ford mass production to new paradigm of production. Although, leanness is the same in all companies, but the process of converting to lean firm provides specific and different outputs in organizations (Shafie&Habibollah, 2011).

Overall, the reviews of related publications present that lean production implementation is repeatedly related to operational improvement. Nowadays, there are still very limited investigations that have been accomplished to provide empirical evidence in favour of lean production implication on operational performance. Therefore, in-depth investigations are still substantially required (Belekoukias, Garza-Reyes, & Kumar, 2014; Chavez et al., 2013; Chen & Tan, 2011; Shah & Ward, 2007). Lean implementation is an advancement in employee productivity and quality of products, along with decrease in production costs, cycle time and customer lead time (Sakakibara*et al*., 1997; White *et al*., 1999; Marynell, 2013, Chanegrih&Creusier, 2016). Yet, some research reported that there is no connection between lean production and operational performance (Swink*et al*., 2005; Hibadullah*et al*., 2013).Although, some studies assert the relationship between lean practice and financial performance (Fullerton &Wempe, 2009; Yang *et al*., 2011; Chanegrih&Creusier, 2016), some studies reject this relationship (Kaplan & Norton, 1992; Fullerton *et al*., 2003; Cannon, 2008; Jayaram *et al*., 2008). Meanwhile, little study such as Fullerton and Wempe (2009) found that there was an effect of lean production on financial performance through operational performance.

Despite these views from researcher's onlean production and operational performance, there is still a lacuna as it pertains to the methodology adopted. Therefore, this study examines the nexus between lean production and operational performance of manufacturing firms in Nigeria with emphasis on the application of structural equation modelling (SEM).

LITERATURE REVIEW

Resource-based View Theory

The Resource-based View Theory (RBV) is a theoretical standpoint that describes and predicts how firms can achieve its sustainable competitive advantage and control over internal resources (Barney, 1991; Wernerfelt, 1984). The RBV lies primarily in the application of superior resources and enables companies to maintain their resources' advantages and sustain their competitive advantages (Barney, 1991). More specific, as stated by Ramayah, Sulaiman, Jantan, and Ng (2004), the fundamental postulation of RBV is leveraging firms' resources and its core competencies to create a sustained competitive advantage, which in turn, interprets into better firms' performance.

Resources discussed within the RBV are not limited to only physical resources. Zahra and Das (1993) divided resources into tangible and intangible resources. Tangible resources are observable; their values can be determined accurately; such as machine, equipment, etc. Tangible resources include human, financial, informational, and technological resources. Conversely, intangible resources cannot be observed which are company's reputation, administrative skills. Subsequently, lean production creates efficient utilization and control over firms' resources with sustained competitive advantages.

CONCEPTUAL FRAMEWORK

Lean Production is a production strategy that integrates social (human) and technical (technology) practices with the primary goal of enhancing business performance through increasing operational performance by continually reducing and eventually eliminating all forms of waste in the production process.

Although, there have been misconceptions among academicians and practitioners in operations management regarding the terms Just-in-Time (JIT), Toyota Production System (TPS), and Lean Production. Slack, Chambers, and Johnston (2010) revealed similarity between lean Production and JIT. Schonberger (2007) stated that practices under lean production were same as JIT's. According to Heizer and Render (2011), there was a little difference among TPS, JIT and Lean production in practice, as a result, the terms TPS, JIT and lean production were often used interchangeably. However, the present study strongly agrees with the postulation provided by Chavez *et al*. (2013) stating that lean production refers to a production system founded by Toyota, which is recognized as TPS. This was also supported by Arif-Uz-Zaman and Ahsan (2014) who stated that the foundation of lean production is TPS, which is based on JIT. This TPS principles have been widely spread toother companies throughout the world, not only automotive manufacturers but also other industries; then the term lean production is preferable instead of TPS. In this study, the term lean production is subsequently used to encompass all the related approaches and techniques, due to the similarity among the three terminologies.

In line with the postulation from Heizer and Render (2011), Schonberger (2007), and Slack *et al.* (2010) as mentioned earlier, although definitions of lean production were continuously expanding, widening, and evolving as the lean Production concept is being more globally accepted (Goyal & Deshmukh, 1992), there was a consensus that the fundamental objective of lean Production is to enhance organization operational performance through waste elimination. Concisely, lean means producing without waste. In Russell and Taylor (2008), Eiji Toyoda (former president of TMC) defined waste as "anything other than the minimum amount of equipment, materials, parts, space and time, which are essential to add value to the products." The waste extends not only within a company but also along its supply-chain networks, within and across companies (Shah & Ward, 2007). Hence, it primarily focuses on eliminating the consumption of resources that adds no value to products and processes. As originally presented by Ohno (1988), there are seven types of waste, which lean Production aims to reduce. They are over productions, unnecessary inventory, defects (or poor quality), unnecessary motions (movement), over processing (i.e., doing more work on a part than necessary), waiting (delay), and transportation. In addition, Womack and Jones (2003) introduced another type of waste, which is known as behavioral waste. This type of waste is related to unused creativity and underutilized human capital (intelligence and intellect). These eight types of waste are all attempted to be eliminated through the deployment of lean Production.

Operational Performance comprises actual outputs of operations strategies employed, which is influenced by operating conditions (such as quality, production flexibility, lead time, inventory, productivity, and costs) and represents some internal properties of production system.Operational performance is the backbone of every industrial, financial, commercial or institutional activities. Operational performance refers to the ability of a company in reducing management costs, order-time, lead-time, improving effectiveness of using raw material and distribution capacity (Heizer *et al*., 2011). Operational performance has an important meaning to firms as it helps to improve effectiveness of production activities and to create high quality products (Kaynak, 2003), leading to increased revenue and profit for companies.

In several sectors of the economy, operational performance is measured to achieve strong, long lasting and growth-oriented results in terms of profits, survival, improvement in processes, efficient and judicious use of resources available to an organization in perfect consonance with clearly laid down policies relating to the operation (Dhillon &Vachhrajani, 2012).

EMPIRICAL REVIEW

The relationship between lean production and operational performance has been examined by several scholars (Piyachat, 2018; Bagshaw, 2018; Udeze, Ugbam, &Ugwu, 2019).

Piyachat (2018) investigated the relationships among lean production, operational performance and firm performance; thereby, the study was conducted and accomplished by means of quantitative method using random sampling and snowball sampling. The results were analyzed by descriptive statistics, confirmatory factor analysis and the structural equation modeling by using statistical software programs. Considering the quantitative approach, a survey was conducted with 629 current middle and top managers working in Thai Manufacturing Industry. The majority of respondents were male (56.3%) of the age above 40 years old (32.6%), factory/production manager (39.1 %), bachelor's degree (75.8%), working in medium size company (36.9%), nonautomotive (60.9%) and company age above 15 years (46.6%). The findings reported that, there were positive relationships between lean production and operational performance, lean production and financial performance and operational performance and financial performance. In addition, the results presented that there was partial effect of lean production on financial performance through operational performance. Considering the structural model level, the results further revealed that the model was not different across the automotive and nonautomotive industry and the model was not different across the lean production adoption <5 years and above 5 years. Regarding the path level, the results reported that all of each path model level was not different across automotive and nonautomotive industry. Similarly, the lean production adoption whether <5 years or above 5 years did not have any effect on all of the path model levels.

Bagshaw (2018) examined the relationship between lean manufacturing and efficiency of 53 manufacturing firms listed with the Manufacturers Association of Nigeria in Rivers State, Nigeria. The questionnaire was used to collect data from respondents and analysed using mean scores, standard deviations and t-statistic in testing stated hypothesis. It was observed that lean manufacturing has a very strong positive and significant influence on efficiency of manufacturing firms. We recommend that management of manufacturing firms should set up clear policies on lean implementation and communicate same to staff. Also, managers of manufacturing firms are encouraged to increase resource commitment by investing in staff training and development so as to inculcate in them skills and knowledge necessary to implement lean practices within the organisations; therefore, professionalism should be encouraged at all levels of the organization. Again, manufacturing firms should pursue quality consciousness through capability surveillance, constant monitoring of suppliers / through put process to ensure production outputs conform to product specification and quality standards should be constantly advocated.

Udeze, Ugbam and Ugwu (2019) investigated the effect of Lean Manufacturing on performance in the Nigerian manufacturing sector. Specifically, the study sought to establish the nature of the relationship between leanness and organizational efficiency in Nigerian manufacturing organizations and to ascertain the extentlean supply chain integration can affect competitiveness in the Nigerian manufacturing organisations. To achieve these objectives, two research questions along with two hypotheses were raised. The population of the study was 2703 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. Hypothesis one was tested using Pearson Product-Moment Correlation Coefficient while hypothesis two was tested with linear regression analysis. After the analysis, the study revealed that: there was a positive correlation between leanness and organizational efficiency ($r = .663$, $p < 0.05$). This implies that leanness in the organization results to efficiency; hence the leaner the entire production processes of an organization, the better its chances to sustain competitiveness. Based on the findings, the study recommends that as a matter of policy, leanness should be practiced in every facet of the organization to enhance efficiency.

METHODOLOGY

This study adopted the quasi-experimental research design because the researcher has limited or no control over the study participants (Leedy&Ormod, 2010). It is a descriptive study as it involves the application of observation and documentation of phenomenon as they occur and cannot be assigned objective values (Sekaran & Bougie, 2011). This study utilised the cross-sectional survey method as it refers to a situation where observations are made about a sample at a period of time (Cooper &Schindler, 2001; Sekaran, 2003).
The study population involved all manufacturing firms in Rivers State. There are sixty-two (62) manufacturing firms in Rivers State (Nigeria Manufacturing Production Commission, 2021). However, the accessible population was four (4) selected manufacturing firms for ease of data collection (See Appendix I).

The Krejcie and Morgan sample size determination Table was adopted to determine the respondents for the study (see table in appendix II). Furthermore, simple proportion was used to arrive at the respondents for each Manufacturing firms (See Appendix III).

Quantitative and qualitative data were collected for this study.Quantitative data for this study were obtained using a structured questionnairetitled Lean Production and Operational Performance Questionnaire (LPOPQ) while the qualitative data for this study were obtained using interview protocol.

The predictor variable is Lean Production has seventeen (17) statementitems adapted from Mohammad, Suhaiza, Sunghyup, Mohd, and Kwangyong. (2019) with the criterion variable which is Operational Performance has sixteen (16) statement items about the managers/supervisor's perception on Operational Performanceas adapted from Rasi, Rakiman, and Ahmad (2015).

Content validity of the instrument was ascertained carrying out a thorough review of literature on the constructs under investigation to ensure that all facets of the constructs are covered in the questionnaire. Face validity was ascertained by given copies of the questionnaire to managers from the Manufacturing companies. These experts will make their inputs on the questionnaire before the final copy will be drafted. Construct validity was determined using AMOS (Analysis of Moments Structure) (Cooper & Schindler, 2001).

Analysis of Moments Structure (AMOS) was used to compute reliability values. Hence, the initial reliability test was conducted using the Cronbach Alpha through the aid of the Statistical Package for Social Sciences (SPSS v25). Only items that return alpha values of 0.70 and above were used; since, this is the threshold value that is generally accepted (Nunnally, 1978; Nunnally & Bernstein, 1994) and therefore, is considered adequate for this study (See Appendix IV).

Structural Equation Modelling (SEM) with the aid of the Analysis of Moment Structure (AMOS) software, version 5 has been chosen as the main statistical method to test the hypothetical model because of the following justifications:Likert-scale ordinal data with large sample sizes tend to have a distribution that is close to normality (Hoyle, 2012); involves simultaneous analyses of multiple interactions (Sarkar, Echambadi, & Harrison, 2001) and is a robust means of prediction and evaluationof the relationship and effect of the exogenous variable on the endogenous variable at the same time (Byrne, 2012).

The qualitative data in this study is organised, coded and analysed using the NVivo 11 Computer Assisted Qualitative Data Analysis Software.

Results and Discussion of Findings

Table 1: Measurement Model Analysis of Lean Production and Operational Performance

Model	Chi-Square(df), Significance	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
Lean Production	(101df)=442, P<0.000	0.82	0.80	0.85	0.10	LP	0.85	0.72
Operational Performance	(272df)=980,P<0.000	0.68	0.69	0.75	0.09	OP	0.58	0.72

Source: Amos 5.0 output on research data, 2022

From result in Table 1 and guided by suggestions provided in Hu and Bentler (1999), acceptable model fit was defined by the following criteria: RMSEA (≤0.6), CFI (≥0.95), TLI (≥0.95), PCLOSE≥0.5, and NFI≥0.95. Multiple indices were used because they provide different information about model fit (i.e. absolute fit, parsimony correction and comparative fit). These indices provide a more reliable and conservative evaluation of solution; when used together. According to Brown (2010), completely standardized factor loadings of 0.3 (or 0.4) and above are commonly used to operationally define a "salient" factor loading.

Each of the goodness of fit indices of lean manufacturing, suggested mild fit to the data (chi-square (101df) = 442, RMSEA=0.10, CFI=0.85, NFI=0.82, TLI=0.80 and PCLOSE=0.00). However, the p value, p<0.000 indicated acceptable fit, as the model was over-identified with one hundred and one degree of freedom.

From result in Table 1 and guided by suggestions provided in Hu and Bentler (1999), acceptable model fit was defined by the following criteria: RMSEA (≤0.6), CFI (≥0.95), TLI (≥0.95), and NFI≥0.95. Multiple indices were used because they provide different information about model fit (i.e. absolute fit, parsimony correction and comparative fit). These indices provide a more reliable and conservative evaluation of solution; when used together. According to Brown (2010), completely standardized factor loadings of 0.3 (or 0.4) and above are commonly used to operationally define a "salient" factor loading.

Each of the goodness of fit indices of operational efficiency, suggested mild fit to the data (chi-square (272df)=980, RMSEA=0.093, CFI=0.75, NFI=0.68, and TLI=0.69. However, the p value, p<0.000 indicated acceptable fit, as the model was over-identified with two hundred and seventy-two degree of freedom.

Correlations and Composite Reliability; Construct: Convergent and Discriminant Validity.
Correlations:

The correlation coefficients indicate that all constructs are significant at the 0.05 levels (2-tailed). The bivariate correlation between lean production and operational efficiency is 0.64. There was no correlation above 0.85 and therefore, multicollinearity was not an issue.

Composite Reliability:

From the results reported in Table 2, the latent constructs reported good composite reliability values, this means that the proportion of the total composite variance that serves as an estimation of the true-score variance of each construct, is above the 0.70 cut off value (Hair *et al.*, 2017).

Construct: Convergent Validity

From the results in the Table 2it shows that all variables have average variance extracted (AVE) values exceeding the 0.50 threshold recommended by Fornell and Larcker(1981). Therefore, it is necessary and sufficient to conclude that the model, has evidence of convergent validity.

Construct: Discriminant Validity

Discriminant validity was accessed based on the criterion recommended by Fornell and Larcker (1981). The criterion states that "the square root of AVE of each construct must be greater than its correlations with other constructs". This means that "AVE must exceed the squared correlation with any other construct" (Hair Jr *et al.*, 2014). In view of this result, it is necessary and sufficient to conclude that the model, has evidence of discriminant validity.

Table 2: Correlations, Composite Reliability, Degree of freedom, Construct: Convergent and Discriminant Validity.

Variable	LP	OP	CR	Df	AVE
LP	**1.0**	0.64	0.88	14	0.72
OP	0.64	**1.0**	0.78	2	0.65
	LP= Lean Production, OP= Operational Performance CR= Composite Reliability, AVE= Average Variance Extracted, Df= Degree of freedom.				

Source: Amos 5.0 output on research data, (2022)

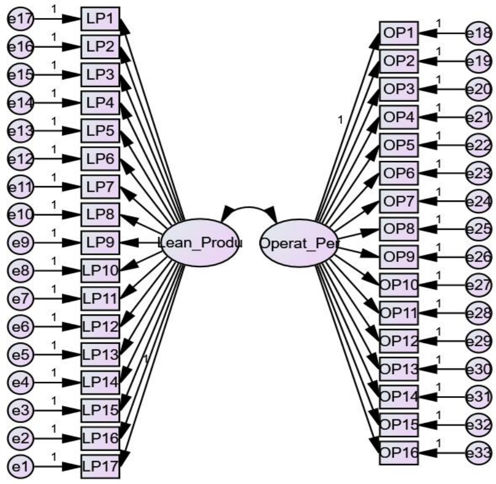

Figure 1: Structural model (linking the predictor and criterion variable)

Test of Hypothesis

Table 3: Result of standardized and unstandardized regression estimate of the model.

S/N	Mediation Stage	Relationship	Std. Beta	Actual Beta	S.E	C.R	P	Remark
1	LP →OE (Hypothesis 1)	Lean production and operational performance	0.66	0.81	0.17	3.92	0.000	Not supported

Source: Amos 5.0 output on research data, (2021)

The analysis was based on significance criteria of $\beta>0.3$ (Brown, 2015); $r>0.7$ (Hair, Hult, Ringle&Sarstedt, 2014) and $p<0.05$.

Hypothesis:

H_O: There is no significant relationship between lean production and operational performance.

H_A: There is a significant relationship between lean production and operational performance.

Relationship between lean production and operational performance of manufacturing firms

Results from Table 3 above illustrates the analysis for the association between lean production and operational performance of manufacturing firms. The findings show a positive and significant association between both variables ($\beta = 0.66$, $r = 0.81$ and $p < 0.05$). Thus, the null hypothesis was rejected which means that there is a significant relationship between lean production and operational performance.

Discussion of Findings

It was hypothesized that, there is no significant relationship between lean production and operational performance of manufacturing firms. The result of the data analysis shows a positive and significant relationship; therefore, this hypothesis was rejected. This implies that lean production has a significant and positive relationship on the operational performance of manufacturing firms. In other words, an effective adoptionlean production could lead to increase in the operational performance through quality of products and services of the business.

This finding aligns with the submission of Piyachat (2018) who investigated the relationships among lean production, operational performance and firm performance and found that there were positive relationships between lean production and operational performance, lean production and financial performance and operational performance and financial performance. Similarly, the finding of this study agrees with the submission of Bagshaw (2018) who found that, organizations who are strategically aligned with their staff and partners, work closely with them and eliminate wasteful time and are flexible.This finding supports the submission of Udeze, Ugbam and Ugwu (2019) investigated the effect of Lean Manufacturing on performance in the Nigerian manufacturing sector to ascertain the extent lean supply chain integration can affect competitiveness in the Nigerian manufacturing organisations.

CONCLUSION AND RECOMMENDATIONS

On the basis of its observations and the empirical evidence, this study observed that lean production contributes significantly towards operational performance.The results further substantiated the assertion that lean production is a critical and highly imperative factor in sustaining business operations and performance; its role as an antecedent to operational performanceis necessitated by the pre-requisites of ideas, creativity, openness to change and confidence in decision-making as fundamental factors in business.

In view of the findings and conclusion, this study recommends thatmanagement of the manufacturing firms should develop procedures and policies which employees will adhere to and ensure routine checks on equipment and service processes. By doing this, the manufacturing firms' resources will be properly managed, thereby enhancing operational performance of the firms.

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APPENDIX I

Table 3.1 Accessible Population for the Study

S/NO	MANUFACTURING FIRMS IN RIVERS STATE	CENTRES HEADS	INDUSTRIAL CLIENTS	MARKETERS
1	AloAluminium Manufacturing Co	49	8	8
2	Paints And Coatings Manufacturers Nigeria Plc	137	10	10
3	Drilling Fluid & Chemical Industry Ltd	28	8	8
4	Syndicated Metal Industries Ltd	372	8	8
	Total	**586**	**34**	**34**
	Grand Total			**654**

Nigeria Manufacturing Production Commission (2021)
(https://www.finelib.com/cities/port-harcourt/business/-manufacturing-industries)

APPENDIX II

Using Table: Krejcie and Morgan

- Assume population proportion of 0.5 and confidence 95%

Population Size	Sample Size	Population Size	Sample Size	Population Size	Sample Size
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346

APPENDIX III

Table 3.2: Sampled Respondents from the Four Manufacturing Firms

S/NO	MANUFACTURING FIRMS IN RIVERS STATE	CENTRES HEADS	INDUSTRIAL CLIENTS	MARKETERS
1	AloAluminium Manufacturing Co	19	8	8
2	Paints And Coatings Manufacturers Nigeria Plc	54	10	10
3	Drilling Fluid & Chemical Industry Ltd	11	8	8
4	Syndicated Metal Industries Ltd	145	8	8
	Total	**229**	**34**	**34**
	Grand Total			**279**

Nigeria Manufacturing Production Commission (2021)
(https://www.finelib.com/cities/port-harcourt/business/-manufacturing-industries)

APPENDIX IV

Variables	No. of items	Alpha Coefficients
Lean Production	17	.884
Operational Performance	16	.783

Source: Data result, (2021)