Artisanal Refineries Productivity and Innovation in Bayelsa State, Nigeria

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Abstract

This study on *artisanal* refineries' productivity and innovation was aimed to investigate improvements in terms of quantity and quality of petroleum products using indigenous and local technology in Bayelsa state of Nigeria. To achieve its objective, the study adopted survey method and primary data was solicited from respondents through questionnaires and personal interviews. Tables and logit regression were used in the data analysis. The findings revealed that there was increase in artisanal refineries productivity and improvement in the quality of petroleum products of petrol, kerosene, diesel, gas, and tar due to innovation. Personal interviews revealed that artisanal refiners used the traditional knowledge of gin distilling in the area to harness petroleum product that reduced the cost transportation in the state. Given the fact that the petroleum sector is a very crucial sector that drives other sectors, the study recommended that there is a dire need for an appropriate and desirable production policy that utilizes indigenous technology in the Nigerian local content policy in the petroleum value chain in Nigeria to propel development.

Key Words: Artisanal Refineries, Productivity, Innovation

Productivité et innovation des raffineries artisanales dans l'État de Bayelsa, au Nigeria

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Abstrait

Cette étude sur la productivité et l'innovation des raffineries artisanales visait à étudier les améliorations en termes de quantité et de qualité des produits pétroliers en utilisant la technologie indigène et locale dans l'État de Bayelsa au Nigéria. Pour atteindre son objectif, l'étude a adopté la méthode d'enquête et les données primaires ont été sollicitées auprès des répondants par le biais de questionnaires et d'entretiens personnels. Des tableaux et une régression logit ont été utilisés dans l'analyse des données. Les résultats ont révélé qu'il y avait une augmentation de la productivité des raffineries artisanales et une amélioration de la qualité des produits pétroliers à base d'essence, de kérosène, de diesel, de gaz et de goudron grâce à l'innovation. Des

entretiens personnels ont révélé que les raffineurs artisanaux utilisaient les connaissances traditionnelles de la distillation du gin dans la région pour exploiter les produits pétroliers qui réduisaient les coûts de transport dans l'État. Étant donné que le secteur pétrolier est un secteur très crucial qui entraîne d'autres secteurs, l'étude a recommandé qu'il existe un besoin urgent d'une politique de production appropriée et souhaitable qui utilise la technologie indigène dans la politique nigériane de contenu local dans la chaîne de valeur pétrolière au Nigeria. pour propulser le développement.
Mots clés : Raffineries Artisanales, Productivité, Innovation

1.0 Introduction

Improving the welfare of people is a major objective of economic development. In a rural setting, this is achieved through the transformation of natural resources to meet the needs of the people with local knowledge and some form of innovation of existing processes. According to Warburton and Martin (1999), knowledge is generated and transmitted that empowers local people not only to observe their surroundings but also to experiment and develop technologies to fit their environment. Similarly, Brondiza, Aumeeruddy, Bate, Carino, Fernandez-Llamazares, Ferrari, Galvin, Reye-Garcia, McElwee, Samakov and Shrestha (2021) asserted that the knowledge, values and practices of native people and communities offer ways to understand and better address social and environmental problems. Likewise, Ford, Cameron, Rubis, Maillet, Nakashima, Wilcox and Pearce (2016), stated that local knowledge is essentially important and has been appreciated in western assessment processes in their own right. However, in the past these often endangered ways of knowledge have been suppressed and attacked (Mustonen, 2014).

Oyeranti (1991) posited that productivity remains the basic problem of economic progress, as it is required at both the early stages of development as well as in the permanent process of re-equipping the production apparatus of any nation. Nonetheless, productivity using traditional knowledge is still discriminated against in the Nigerian petroleum sector. This is showcased in the destruction of artisanal refineries that were meant to serve the economic needs of the people in the Niger Delta region of Nigeria.

In the 1950s and 1960s, a popular view was that scientific knowledge through the transfer of technology applied to problems of rural poverty in developing countries would provide the necessary drive desired to transform rural people’s lives and raise their welfare. This has been disputed by the increasing evidence that many development projects were not working well (Warburton and Martin, 1999).

Petroleum resources contribute largely to Nigeria’s foreign earnings. Nigeria focuses on increasing its crude oil production and refining capacity to convert the crude oil from its original form to the form mostly desired (Hildebrand 1972). Also, Nigeria Vision **20:2020** states that the increase in crude oil production and refinery capacity will stimulate local value-addition and strategically position the nation to meet its domestic demand for refined products and take advantage of a new market niche- export of refined products. Furthermore, section 16 of the constitution of the Federal Republic of Nigeria (1999) stipulates the need to harness the resources of the nation and promote national prosperity and an efficient, dynamic and self-reliant country.

Despite these goals, Nigeria is far from achieving these targets and has not been able to significantly improve supply constraints of various products to the market, thus

relying on petroleum products importation with the commitment of enormous resources in subsidizing these imports while the existing standard refineries that are bedeviled with operational problems. Additionally, the removal of fuel subsidy in the 2023 national budget without adequate preparation of petroleum products supply is another problem in the short run.

The interaction between the people and natural resources is aimed at sustaining lives in a given environment as cited in extant studies (Mustonen, Harper, Pecl, Broto, Lansbury, Okem, Ayanlade, Dawson, Harris, Feodoroff, McGregor, 2022). However, literature on the conversion of petroleum resources using local people's knowledge for sustainability is scanty. Also, there is a general consensus that lack of specialized skills is a major problem to Africa's realization of its resource potentials (Nwapi, 2016). Thus, the focus of this study is to examine *artisanal* refineries productivity and innovation in Bayelsa State, Nigeria.

The rest of the paper proceeds as follows: In Section 2, the empirical literature is discussed. Section 3 presents the methodology. Section 4 provides the results and discussion of findings. Section 5 is the conclusion and recommendation

2 Literature Review

Productivity means different things to different people and ranges from effectiveness to efficiency, to rates of turnover and absenteeism, to output measures, to measure of the client or consumer satisfaction, to intangibles such as disruption in workflow, and intangibles such as morale, loyalty and job satisfaction (Oyeranti, 1991). In this paper, productivity means effectiveness, and rate of turnover to measure output and improvement.

Drucker (1970) described innovation as the purposeful and deliberate attempt to bring about, through technological means, a distinct change in the way man lives and in his environment-the economy, the society, the community, and so on. Innovation, according to the study, may begin by defining a need or an opportunity, which then leads to organizing technological efforts to find a way to meet the need or exploit opportunity. According to Wallace (nd) in Drucker (1970), technology is mastery of man's environment. Technological invention and the development of industries based on new knowledge were in the hands of craftsmen and artisans with little scientific education but a great deal of mechanical intelligence. Okorafo (2014) pointed out that technology is the product of creativity and innovation. Aye-Agele and Inyang (2019) opined that industrial development is planned in phases and involves crude and simple items to complex and refined goods.

Artisanal refineries are those constructed and operated entirely with local knowledge through interaction between the people and the natural resources that provide petroleum products such as diesel, petrol, kerosene, tar, and gas products. Local knowledge means the understandings and skills developed by individuals and populations, specific to the places where they live (UNESCO, 2018).

The endogenous theory views continuous technological innovation as the strongest antidote to the limits of growth and explains the long-run growth rate of an economy based on endogenous factors (Jhingan, 2016). The King-Robson model emphasizes learning by watching their technical progress function. Investment by a firm represents innovation to solve the problems it faces. If it is successful, the other firms will adapt the innovation to their own needs. Thus, externalities resulting from learning by watching are a key to economic growth.

Jhingan (2016) posited that the use of foreign capital by multinational companies monopolizes investment in minerals, petroleum, and plantations to maximize their gains at the expense of developing countries. Warmer (2007) viewed local content from an angle of community content to have a competitive advantage through the conscious building of capacity of national and local skills to access opportunities considered as local capability development. Umukoro (2018) posit that a homegrown solution for petroleum refining in the Niger Delta is harnessed for petroleum refining in Nigeria and contend that the Nigerian government reconsider the destruction of indigenous refineries and also review extant laws on refining petroleum products.

Nwapi (2016) stated that one instrument adopted by most oil and gas resource-rich countries to deal with the skills problem and to enhance linkage between the oil and gas sector and other sectors is the formulation of local content policies (LCPs) which ensures a given percentage of domestic value added or domestic components be embodied in a final specified product. According to Melo and Rodriguez (2006), LCPs strengthen the productive structure of a particular national economy.

Stakeholders Democracy Network [SDN] Report (2019) adopted both qualitative and quantitative research in Rivers and Bayelsa states on *artisanal* refineries. Their analysis indicates that all levels of the *artisanal* value chain are better organized and more profitable than some years ago. Based on an increased absorptive capacity per camp, it was estimated that they were five times the number of refineries as there are in previous years. The report opined the need to demonstrate the feasibility of this approach to scale up and replicate pilot projects in other locations for an alternative policy response approach.

Obenade and Amangabara (2014) noted that the argument put forward for *artisanal* refinery hinged on the perceived industry's unwillingness and government's inability to work towards ameliorating the deplorable conditions of the oil-producing communities of the Niger Delta. Though UNEP (2011) observed that oil refining activities carry significant health risks. The handling and heating of the crude oil pollute the air with the camps having a toxic feel and communities are constantly exposed to inhalation of poisonous gases, causing coughing and breathing problems. Atah (2012) posited that *artisanal* refining activities have generated a burgeoning economy for the Niger Delta as it creates a well-developed supply chain that includes trained engineers, women, and youths for labour supply.

Besides, Braide (2017) argued that decriminalization and transition from illegal *artisanal* refining to regulated refining using standard modular refineries is to creatively leverage on already existing indigenous petroleum products processing know-how and experience that is resident in the oil-producing communities in the Niger Delta region of Nigeria; and proceed to nurture a conducive environment for stimulating the domestication, growth and progressive advancement of indigenous petroleum refining technology in Nigeria in a structural manner. This to a great extent will mitigate problems such as price shocks, capital flight, and product availability in the industry

3.0 Methodology

The study was carried out in communities of three local government areas representing the three senatorial districts of Bayelsa State. The generation of data for this study was based strictly on fieldwork through questionnaire-based surveys and personal interviews. A set of questionnaires was proportionately administered on producers or vendors of petroleum products or materials in the communities before the clampdown

on the refineries. Part one of the questionnaire captured basic biographic information of the respondents while part two consisted questions where respondents' views about the operations of artisanal refineries were sought. The target population for the study was 446,043 people representing the total registered voters in the three local government areas in 2015.

LGA	Registered Voters
Southern Ijaw	188,778
Ekeremor	137,518
Ogbia	119,747
Total	446,043

Source: Independent Electoral Commission 2015

The sample size was obtained using the formula for determining the needed sample sizes for research activities (Krejere and Morgan, 1970). The sample size is computed as follows:

$$Size = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

X^2 Table value of chi-square at d.f I and a 0.05

N Population size

P Population proportion (assumed to be 0.50)

d Degree of accuracy (expressed as a proportion)

$$Size = \frac{3.841(446043)(0.50)(1-0.50)}{0.05(446043-1) + 3.841(0.05)(1-0.50)}$$

$$\text{Sample size} = 201$$

To select the sample size for each local government area, simple percentage was used as follows:

Table 1**:** Distribution of sample sizes among the registered voters in Southern Ijaw, Ekeremor, and Ogbia Local Government Areas of Bayelsa State.

S/N	LGA	Registered voters	Percentage (%)	Sample size
1	Southern Ijaw	188,778	42.3	$\frac{42.3}{100} \times 201 = 85$
2	Ekeremor	137,518	30.8	$\frac{30.8}{100} \times 201 = 62$
3	Ogbia	119,747	26.9	$\frac{26.9}{100} \times 201 = 54$
Total		446,043	100%	

Source: Authors computation

Table 1 showed the distribution of 201 questionnaires to respondents out of which 85, 62, and 54 were distributed to respondents in Southern Ijaw, Ekeremor, and Ogbia local government areas respectively. The total number returned was 167 with 75, 52, and 40 from the three local government areas representing 83%.

3.1 Model Specification

Productivity measurement is the quantification of both the inputs and outputs of a production process. The goal of productivity measurement is productivity improvement, which involves a combination of increased effectiveness and a better use of available resources (Oyerantgi, 1991). Under the assumptions of constant returns to scale and competitive markets, the rate of growth of output can be written as follows:

$$g_y = \alpha g_b (1-\alpha) g_k + q \qquad (1)$$

where g_y, g_b and g_k are the growth rate of output, labour, and capital respectively, and α is the share of labour in output, while q measures that part of the growth that cannot be explained by either growth of labour or capital.

Equation (1) is transformed to suit the purpose of this study which is to investigate innovation and productivity to bring about increased effectiveness in the artisanal refineries in petroleum products production in Bayelsa State, Nigeria. It is assumed that q is an innovation that cannot directly explain productivity

$$g_y = \sum q \qquad (2)$$

where ∑q is a vector of factors that promotes innovation and productivity such as local peoples knowledge (LPK), elementary science (SCI), petroleum engineering (PTE), and government-sponsored training programme (GTP).

Thus, apart from the background information of respondents, questions relating to how knowledge was acquired in productivity improvement were asked; such as traditional knowledge, elementary physics, advanced training in petroleum engineering, and government training programme. Therefore, the model for this study is specified as follows:

$$Y_i = \beta_0 + \beta_1 LPK_i + \beta_2 SCI_i + \beta_3 PTE_i + \beta_4 GTP_i + \varepsilon_i \qquad (3)$$

Where
Y = Output
LPK = Local Peoples Knowledge
PHY = Elementary Science
PTE = Petroleum Engineering
GTP = Government Training Programme
β_0 = intercept
$\beta_1, \beta_2, \beta_3, \beta_4$= slope

4 Results and Discussion

Table 2: Gender of respondents

Gender	Freq	Percent	CumULATIVE
Male	112	67.47	67.47
Female	54	32.53	100
Total	166	100	

Source: Author's computation

Table 2 presented the distribution of respondents based on gender. It shows that the male respondents were more than the female counterparts in the study area. With a total of 166 respondents, the highest of 112(67.5%) respondents were males. This indicates that the male gender was more involved in artisanal refining than females when the refineries were operational .

Table 3: Age of respondents

Age	Freq	Percent	Cumulative
15 – 24	56	33.73	33.73
25 – 34	59	35.54	69.28
35 – 44	24	14.46	83.73
45 – 54	23	13.86	97.59
> 55	4	2.41	100
Total	166	100	

Source: Author's computation

Table 3 presents the distribution of respondents based on age variable. Out of 166 respondents, 35.5 % percent were in the 25-34 age brackets followed by ages 15-24 that constituted 33.7 percent. It therefore shows that the active labour force and those of schooling age were involved in the artisanal refineries

. **Table 4**: Educational qualification of respondents

Education	**Frequency**	**Percentage**	**Cumulative**
Degree	38	22.89	22.89
School certificate	89	53.61	76.51
FSLC	39	23.49	100
Total	166	100	

Source: Author's computation

Table 4 showed the level of education of respondents in the study area. The educational qualification status is to show the educational attainments of respondents.

The study discovered that approximately thirty percent 53.6 per cent of respondents had School Certificates or its equivalent. This indicates that the zeal for educational pursuit was sacrificed for the artisanal refining business and the tendency for low higher education pursuit in the state.

Table 5: Local Government Area of respondents

LGA	Frequency	Percentage	Cumulative
Southern Ijaw	68	40.96	40.96
Ogbia	51	30.72	71.69
Ekeremor	47	28.31	100
Total	166	100	

Source: Author's computation

Table 5
showed the local government of origin of respondents in the study area. The study observed that 68 respondents (40.96%) were from Southern Ijaw local government area. The higher number of respondents from Southern Ijaw may not be unconnected with the numerous pipeline networks in almost bushes, creeks and rivulets in the local government. Some communities are also located at the sea shore where some petroleum exploration companies operate off shore petroleum exploration.

Table 6: Reliability test

Average interitem covariance	0.447
Number of items on the scale	5
Scale of reliability	0.562

Source: Authors computation

The result of the reliability test is shown in Table 6. The scale reliability test shows 0.5620 (approx 0.6) indicating the strength of the association of the independent variables and the outcomes. LR chi(4) having 30.97 with probability 0.000 tells us that our model as a whole is statistically significant, that is, it fits significantly better than a model with no prediction.

Table 7: Logit Regression results

Variables	Coefficient	Std. Err	Z	$P > \|Z\|$	$[95\% \ confidence \ interval]$	
Lpk	1.121	0.493	-2.270	0.023	-2.087>	-0.154
Sci	-0.767	0.366	-2.09	0.036	-1.685>	-0.492
Pte	-0.990	0.385	-2.570	0.010	-1.744>	-0.236
Gtp	-0.378	0.378	-1.00	0.317	-1.119>	0.362
Cons.	4.548	1.090	4.17	0.000	2.412>	6.685

Source: Author's computation

The results of the logit regression are shown in Table 7. Petroleum product improvement (ppi) is our dependent variable. The independent variables include local people's knowledge (lpk), elementary science (sci), petroleum engineering (pte), and government-sponsored training programme (gtp) which describes the methods used in petroleum products production and improvement. From the results, it is found that all the variables except lpk are negative. The positive coefficient of lpk indicates that people utilize more local knowledge in petroleum products production and improvement in rural communities. This means that for a one-unit increase in lpk, we expect a positive 1.12 increase in the log odds of the dependent variable, petroleum products improvements. Thus we reject the null hypothesis that lpk does not improve petroleum products improvement. This result agrees with the findings of Stakeholders Democracy Network (2019).

The positive result of lpk coefficient collaborates with personal interviews with respondents who stated ingenuity of local refineries operators with the traditional knowledge of gin distilling in the area to harness petroleum products. However, harnessing of gas was attempted with inconsequential results. The personal interviews further indicate that petroleum products were affordable at minimal cost to end users and cheaper transport costs to commuters.

The negative coefficients of sci and pte indicate that production and improvement become less likely because people do not use these methods in the production processes. All the independent variables except gtp are statistically significant indicating that changes in the variables are associated with changes in the probability that petroleum product improvement might occur. Gtp is statistically insignificant and indicates that there is no form of training by the government in the production process

.**Table 8**: Marginal effects after logit

Variables	Coefficient	Std. Err.	**Z**	$P > \|Z\|$	$[95\% \ C.I.>]$	**X**
Lpk	0.271	0.117	-2.30	0.021	-0.501 -0.402	1.259
Sci	-0.185	0.088	-2.10	0.036	-0.358 -0.119	1.506
Pte	-0.239	0.093	-2.560	0.010	-0.422 -0.563	1.723
Gtp	-0.913	0.091	-1.000	0.316	-0.270 -0.873	1.717

Source: Author's computation; y =Pr(ppo) (predict) = 0.408

The results in Table 8 shows the marginal effect after logit of lpk, sci, pte, and gtp or an infinitely small change in the independent variables of .27.-.19, -.24, and -.09 (dy/dx values) on the dependent variable petroleum products improvement (ppi).

5. Conclusion and Recommendation

The investigation revealed that most of those who participated in the refining process were youths and were either secondary school leavers or graduates who took to the business as self-employment. Personal interviews with respondents revealed participants of artisanal refineries used traditional knowledge of gin distillation to produce petroleum products. The process succeeded in controlling the waste and instead of spilling it into the waters was able to harness it for commercial use. Harnessing of flames into gas was attempted although with insignificant results. All these improvements were aimed to reduce the flares to reduce smoke dispelled into the air and pollution on the land and rivers. The personal interviews further indicate that petroleum products were affordable at minimal cost to end users and cheaper transport costs to commuters.

Arising from the above investigation and for development in the petroleum sector in a deregulated economy, the need for local refining is imperative and is necessary to be built into the Nigerian Local Content policy to train the local people in the production process. There is a growing demand for petroleum products with the growth of the economy with cases of increased prices and shortages of the products in the Nigerian economy. The demand for these products, although inelastic and is very fundamental input to all sectors of the economy. Given the fact that the petroleum sector is a very crucial sector that drives other sectors, there is a dire need for an appropriate and desirable production policy that utilizes indigenous technology in the petroleum value chain in Nigeria to propel development with appropriate inclusive economics.

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