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Analysis of the Variation in the Cost Implications and Monetary Benefits of Artisanal Oil Refinery in the Niger Delta, Nigeria

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Abstract:- The study analysed the variation in the cost implications and monetary benefits of artisanal oil refinery in the Niger Delta, Nigeria.A total of 1200 questionnaire were administered on community dwellers, while 313 copies were administered on artisanal refinery owners in the study area, however, 1140 of the questionnaires administered on community dwellers were returned. Descriptive statistics were used for data analysis. Results showed that males were more than females in both affected communities and artisanal refineries workers and most of the respondents are found within the working age brackets (18-45 years). Among the affected communities, 27% were businessmen while 21% were students. More of the respondents in the affected communities had no formal education than that of the artisanal refinery workers. Results also showed that generally it takes between one (28.1%) to two (22.3%) weeks to complete an artisanal refinery. The spill over is completed in the third week (22.3%). This pattern does not follow in all the states. The study can be concluded that the time and financial cost of running an artisanal refinery is low and thus encourages locals to invest in it. The consequence of such sporadic opening of poorly developed refineries is severe on not only those operating the refineries but, on the communities, as well. Based on this, the study recommended that government and well-meaning Nigerians should team up to chart a proper way of refining crude, which were both health for operators and locals, and more sustainable.

Keywords:- *Cost, Monetary benefits, Artisanal, Crude oil, Oil spill, Niger Delta.*

I. INTRODUCTION

Artisanal refining is the refining of crude oil with the use of indigenous resources and skills by collecting the crude oil into drums and heating them to boiling afterwards allowing them to cool and condense.Artisanal refineries apply the same principle of distillation used by conventional refineries. It involves the buying of stolen crude oil and refining them using local resources and skills. These local resources/skills are synonymous with those employed in refining local gin in Nigeria (UNEP 2011, Akanimo 2013).

According to Environmental Impact Assessment (EIA) 2005, petroleum also known as crude Oil is a term used to refer to "Rock Oil". It is a smelly, yellow/black liquid usually found in reservoirs underground. It is made up of mixtures of gaseous, liquid and solid hydrocarbons (Arene & Kitwood, 1979). Some crude oil contains sulphur, organic nitrogen compounds and organic acids and they can either be used as fuel or in the synthesis of organic compounds (Eneh, 2011).The process by which useful products are obtained from crude oil is known as refining (Saepudin, et al., 2010; Sharma 2002). Crude oil once extracted from the ground is transported via pipelines or barge to refineries for its purification into various valuable and useful products. A refinery is a facility set up for converting crude materials into finished and desired products. This facility is made up of different units with different processes. There are different types of refineries for the processing of different raw materials but of major interest is the oil refinery.

A refinery employs both physical and chemical processes which include distillation, extraction, reforming, and hydrogenation, cracking and blending to bring about petrol, diesel, kerosene, petroleum coke, bitumen, liquefied petroleum gas, lubricating oil and heating fuel oils and petrochemicals for use both internally and externally (Babich&Moulijn 2003).The proportion of the products got from the refineries varies with both the refining process and the type of crude oil. For instance, Eneh 2011 reported that Nigerian crude oil is in high demand because of its low sulphur content of about 0.14% compared to others. The authors added that most Nigerian refineries yields 20% Kerosene, 10% Petrol and 30% gas with the other products making up the remaining 40%. Crude oil is measured in barrels (bbls).

These benefits accruable from crude oil are not without challenges which are basically environment related such as soil, water and air pollutions. For instance, oil spillage may alter soil properties as well as ecosystem functions. Water pollution from crude oil also kills aquatic life and disrupts the water quality. The same can also be said of burning of petroleum products which gives rise to carbon dioxide which is majorly responsible global warming. It also results to the emission of other harmful gases dangerous for human inhalation. Most of these pollutants have been linked to the presence of sulphur in crude oil.

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In addition, the method and techniques for getting these crude oils from the ground, transporting them to the refineries and refining them may also affect the environment. These could lead to the destruction of the ecosystem as well as the primary source of livelihood of rural dwellers such as farming, fishing and animal rearing (Ugwu 2009; Al-Turki, 2010).

The emissions and the quality of fuels produced from the refineries are the most important issues as far as the environment is concerned. To this end, the United States Environmental Protection Agency (EPA) enacted the Clean Air Act tier 2 in 1999 with the aim to reduce the level of environmental pollution by the refineries by reducing the sulphur content since the Carbon dioxide emitted also by these refineries is limited by the Kyoto protocols on climate change 1997.

Developed Nations such as the United States of America and Canada are investing huge sums of monies in response to the environmental clean fuel legislation (Venner, 2000).With more emphasis on the preciousness of crude oil and less concern with the environmental effects associated and also due to the fact that refineries in Nigeria do not meet the changing needs of the society as it concerns products specification and quality by improving on existing technologies (Katzer et al., 2000), there is eruption of artisanal refineries worsening the situation.

Nigeria currently has four refineries, two in Port Harcourt, one each in Kaduna and Delta states. The two refineries in Port Harcourt come together as the Port Harcourt Refining Company (PHRC) with a capacity of 210,000 barrels per stream a day. The Warri refinery known as Warri Refining and Petrochemical Company (WRPC) with a capacity of 125,000 barrels per stream a day and the Kaduna refinery known as Kaduna Refining and Petrochemical Company Limited (KRPC) and has a capacity of 110,000barrels per stream a day. The capacity of the four refineries sum up to 445,000 barrels per day (Adeyemo, 2018) but since their construction, none have worked up to 50 percent of its capacity according to the Nigerian National Petroleum Commission (NNPC show).

Eneh (2011) posits that the type of crude oil and the distillation process employed are major determinants of the amount of refined products obtained. For instance the yields obtainable from Nigeria refineries are approximately 30% of gas, 20% of kerosene and 10% of petroleum all summing to 60%. Thus more refineries are needed to meet up with the growing demands.

A modular refinery is a miniature form of conventional refinery constructed in a fragmented way (Brown et al., 2003; Igwe, 2015; Manudu&Okonkwo, 2016). The idea of modular refineries which was first mooted in the early 1940's was revamped in the 1970's as solutions to the problems linked to conventional refineries (Hogan 1974).Globally the idea of modular refineries is applied when the refined product fall short of demand. Its idea was that of a temporary refinery which can easily be hidden or dismantled as need arises (Duncan & Knox, 1991).The set-up of a modular refinery allows for refinery three major functions such as crude oil separation, conversion and treatment (Mamudu*et al.*, 2019). These include separation of crude oil into different fractions such as diesel, kerosene, naphtha, petroleum gas and other bye products by the distillation unit in a relatively cheap process compared to the conventional refineries. Hydro skimming unit to ensure high octane unleaded gasoline and LPG which may include the addition of isomerization unit to boost the total octane rating and produce premium unleaded gasoline. Full Conversion Unit also known as a full conventional refinery. This includes the addition of a hydro-cracker and fluid catalytic cracking unit and functions by converting light and heavy gas oils to more valuable lower boiling point products. This significantly increases the yield making it a substantial contributor to refinery profitability (Energy, 2015).

According to Mamudu*et al.*,(2019), setting up modular refineries at strategic locations in Nigeria will aid the nation in a number of areas which include supporting the low performance of the existing refinery. A modular refinery will help to rapidly meet local demand with relatively low capital cost; eradicate the shortage of petroleum products across the country; drastically help to minimize our reliance on imported petroleum products; totally remove the need for subsidy, encourage private investors since start-up capital is low compared to a conventional refinery; remove the factor of vandalization as pipelines will not be laid across a wide area; and ensure optimal use of our resource which has a multiplier effect on the economy. The previous studies have really dug in-depth into various ways that artisanal refineries could be of benefit to the society of the developing nations like Nigeria and also the cost implication that is attached to its establishment in which the present study is focusing at. Against this backdrop, the study is analysing the variations in the cost implications and monetary benefits of artisanal oil refineries in the Niger Delta Region of Nigeria.

II. MATERIALS AND METHODS

The study was carried out in the selected States in the Niger Delta which include Rivers, Bayelsa, and Delta States. The Niger Delta Region sits directly on the Gulf of Guinea in the Atlantic Ocean (Michael-Hogan 2013). The present-day Niger Delta covers a mass of 70,000 km^2 and make up 7.5% of Nigeria's land mass (Figure 3.1). The region is in the Southern part of Nigeria and stretches within Latitude 4^0 12' 30.892"N through Latitude 4^0 50' 10.7"N and Longitude 4^0 56' 15"E through longitude 9^0 40' 2.654"E. The area location makes it accessible to a lot of crude oil reserves on one hand and porous to crude oil theft and the proliferation in artisanal refining over the years. The study area has a tropical monsoon climate with mean annual temperature of 28°C and annual rainfall over 2500mm. The relative humidity is very high with an annual mean of 85%. The relief is generally lowland which has an average of elevation between 20m and 30m above sea level and the geology of the area comprises basically of alluvial sedimentary basin and basement complex. The vegetation found in this area includes raffia palms, thick mangrove forest and light rain forest. The soil is usually sandy or sandy loam underlain by a layer of impervious pan and is always leached due to the heavy rainfall. The study area is well drained with both fresh

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and salt water. The salt water is caused by the intrusion of sea water inland, thereby making the water slightly salty.

The target population comprised the household and artisanal refinery sites across the selected states of the study area. Table 2 shows the number of households which constituted the target population from which the appropriate samples were selected. To get the household size, the total population of the local government area was divided by 5 (the household size as determined by NPC, 2006). The Taro Yamane formula (Equ. 1) was used to determine the sample sizes for each state. Hence, each state had a sample size of 400 each. The research instrument was administered on 400 heads of households in each study state within the study area. Conversely, the artisanal refineries were enumerated, and 1324 sites were determined. The Taro Yamane equation (Equ. 1) was deployed and a sample size of artisanal site was derived (313) as presented in Table 1. To avoid bias, the determine Taro Yamane sample was proportionally distributed both for the artisanal refineries and the household sizes (Tables 1 & 2).

Yamane formula as follows:

$$n = \frac{N}{1+ N(e)^2} \quad n = \frac{1324}{1+ 1324\ (0.05)^2} = 307\text{……..equ (3.1)}$$

where:
n = sample size
N = Population size (owners of artisanal refineries)
1 = Constant
e = error limit or margin of error or level of significance (accepted error set at 5% i.e. 0.05)

States	Number of Artisanal Refining	Sample Size
Rivers	521	123
Bayelsa	721	171
Delta	82	19
Total	1324	313

Table 1: Artisanal Refining sites across the states

Source: Researcher's Field Work, 2020

STATES	LOCAL GOVERNMENT	2006 POPULATION	2020 POPULATION PROJECTED	HOUSEHOLD SIZE	SAMPLE SIZE
BAYELSA					
	Yenagoa	352285	475969	95194	87
	Southern Ijaw	321808	434792	86958	79
	Brass	184127	248772	49754	45
	Nembe	130966	176947	35389	32
	Ekeremor	269588	364238	72848	66
	Ogbia	179606	242664	48533	44
	Sagbama	186869	252477	50495	46
Total		**1625249**	**2195859**	439172	**400**
DELTA					
	Ughelli	166029	224320	44864	27
	Warri South West	116538	157453	31491	19
	Warri North	136149	183949	36790	22
	Burutu	207977	280996	56199	33
	Ughelli	302687	408957	81791	49
	Ndokwa	150024	202696	40539	24
	Warri South	311970	421500	84300	50
	Sapele	174273	235458	47092	28
	Isoko South	235147	317705	63541	38
	Ethiope West	202712	273882	54776	32
	Ughelli South	212638	287293	57459	34
	Warri North	136149	183949	36790	22
	Isoko North	143559	193961	38792	23
Total		**2495852**	**3372119**	674424	**400**
RIVERS					
	Degema	249467	337052	67410	23
	Ogba/Egba/Ndoni	283294	382756	76551	26
	Akuku Toru	161103	217664	43533	15
	Eleme	190194	256969	51394	17
	Gokana	233813	315902	63180	21

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	Ahoada West	249232	336735	67347	23
	Tai	120308	162547	32509	11
	Bonny	214983	290461	58092	20
	Ahoada West	249232	336735	67347	23
	Oyigbo	125331	169333	33867	11
	Abua/Odual	282410	381561	76312	26
	Ikwerre	188930	255261	51052	17
	Etche	249939	337690	67538	23
	Obio/Akpor	462350	624677	124935	42
	Andoni	217924	294435	58887	20
	Emuoha	201057	271646	54329	18
	Port Harcourt	538558	727641	145528	49
	Ahoada East	166324	224718	44944	15
Total		**4384449**	**5923783**	1184757	**400**

Table 2: Sample distribution across the affected Local Government Areas

A total of 1200 questionnaire were administered on community dwellers, while 313 copies were administered on artisanal refinery owners in the study area, however, 1140 of the questionnaires administered on community dwellers were returned. The reasons for the non-return copies include poorly answered questions, defacement of the questionnaire by rain or the respondents and COVID 19. However, Soonk (2019) adduced that 95% of questionnaire return for a properly sampled population is adequate. As for the copies administered on artisanal refinery owners 310 were returned. This means that 99% of the questionnaire administered on artisanal refinery owners was returned. This implies that 95% of the copies of questionnaire administered were returned. Descriptive statistics were deployed for the data analysis and results were presented in tables and graphs

III. RESULTS AND DISCUSSIONS

A. Socio-Demographic Characteristics of Respondents

Table 1 shows the relevant demographic information of the respondents. As for the community dwellers, 53% were males while 47% were female. Contrastingly, the gender disparity for artisanal refinery respondents shows that the activity is male dominated with 80.6% of respondents being male. The perception has also been documented by Manudu and Okonkwo, (2016), who suggested that the activity is male, dominated because it is physically tasking, and sometime crime related. The age distribution for community dwellers showed that majority of the respondents fell between 25 and 44 years. This age category jointly represented 70% of the respondents at the community level. The age distribution for the artisanal refinery owners showed that those above 50 years (42%) dominate. The reason for this is not farfetched. The siting of the refinery needs both money and influence, which can be age selective in the area. Also, the age bracket of 18-24 had no respondent. This further buttresses the alluded position. The community respondents that were single accounted for 42%, those married accounted for 38%, the divorced and widowed jointly accounted for 20%. On the other hand, the married among the refinery owners accounted for 39.7% while the single among them were 45.2%. This means that, some of the artisanal refinery owners may be running it as a family business, which engages households.

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Categories	Affected community dwellers		Artisanal refineries	
Sex	Frequency	%	Frequency	%
Male	604	53	250	80.6
Female	536	47	60	19.4
Total	1140	100	310	100
Age Bracket (yrs)				
18-24	128	11	00	00
25-29	164	14	42	13.5
30-34	199	18	35	11.3
35-39	182	16	54	17.4
40-44	182	16	26	8.4
45-49	173	16	22	7.1
>50	112	10	131	42.3
Total	1140	100	310	100
Marital Status				
Single	481	42	140	45.2
Married	425	38	123	39.7
Divorced	119	10	12	3.9
Widowed	115	10	35	11.3
Total	1140	100	310	100
Level of Education				
No Formal Education	343	30	89	28.7
Primary Education	418	37	102	32.9
Secondary Education	198	17	92	29.7
Tertiary Education	181	16	27	8.7
Total	1140	100	310	100
Occupation				
Fisherman/Fisherwomen	167	14		
Trader	187	17		
Farmer	152	13		
Student	244	21		
Business	300	27		
Government Employee	90	8		
Total	1140	100		

Table 3: Socio-demographic characteristics of Respondents

A close look as the data shows that education is a problem in the area. For the community dwellers, only 16% have any form of tertiary education. Contrary wise, 30% of the respondents do not even have any form of formal education at all. This shows the level of negligence of the affected areas when it comes to provision of adequate formal education. Sadly, this accounts partly for the rate of pipeline vandalism in the area (Yabrade&Tanee, 2016). As for the education levels of the artisanal refinery owners 32.9% and 29.7% of the respondents had primary or secondary school education at least. However, that 28.7% of the respondents have no formal education is dangerous. This means that most of the artisanal refinery owners have had nothing but informal training on how to process crude oil (the process of refining). This also means that, it is highly probable that such persons have no training in environmental management, and human health protection. This is dangerous not only for the local environment, but also for the adjoining ones. The occupation of the locals was revealed to include Fishing, trading, farming, business and government employs. Those who engage in business (27%) and those who are students (21%), shows that there possibly is a serious environmental problem. In a supposed rural environment, this is a dangerous development. The rural resources should be engaged, and agriculture and fishing should represent the activity that engages people more if the environments were favourable.

B. The cost implications and monetary benefits of running artisanal oil refinery

The time and financial cost of building an artisanal refinery in the study area is presented in Table 2. Also, the monetary benefit (that is how much is made as a result of investments in artisanal refinery) is presented in Table 2.Overall, it takes between one (28.1%) to two (22.3%) weeks to complete an artisanal refinery. The spill over is completed in the third week (22.3%). This pattern does not follow in all the states. At the state level most Bayelsa respondents alluded that it takes one (31.5%) to two (50.6%) weeks to complete an artisanal refinery. In Delta State most respondents identified that it takes three weeks (52.6%) to complete an artisanal refinery in the area. For Rivers State, most respondents suggested that it takes between two (38.2%) to three (30.9%) to complete an artisanal refinery. The reason for the spatial disparity in the building of the refineries may be related to availability of the financial power of the intending investor and the lucrativeness of the business that exists in Bayelsa and Rivers State, that may not be in Delta State.

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It is fairly cheap to erect an artisanal refinery in the area. This is by considering the opinion of the respondents. Overall, the cost of siting an artisanal refinery falls within #201000 and #400000 thousand (61.2%). However, in Bayelsa State majority (53%) of the respondents opined that it costs #201000-#300000 to site an artisanal refinery. In Rivers State, the amount of money needed to site an artisanal refinery ranged from #100000 to above #400000, although majority of the respondents identified that it costs #301000-#400000 (33.3%) to complete an artisanal refinery. Compared to the amount they can make from these refineries (though illegal), the amount needed to set it up is relatively small and can hence be sort for by intending investor.

An inquiry into the daily income of the investors in artisanal refineries in the study area shows that income ranges from 50 thousand naira to above 300 thousand naira. This means that the business has a reckonable return on investment, with propensity of realizing total investment in a week, albeit with health and environmental costs. The business appears to be more lucrative in Rivers state as 45% of the respondents alluded to realizing #201000-#300000 daily for local sale of products, and 46.3% for international sales. Conversely, Delta state has the lower income levels with most of the respondents suggesting that they make about #100-#200000 daily from sale of products.

States	**Time for camp building**					
	1wk (%)	**2wks (%)**	**3wks (%)**	**4wks (%)**	**>4 wks (%)**	**Total (%)**
Bayelsa	53 (31.5)	85 (50.6)	21 (12.5)	7 (4.2)	2 (1.2)	168 (100)
Delta	3 (15.8)	5 (26.3)	10 (52.6)	1 (5.2)	00 (00)	19 (100)
Rivers	31 (25.2)	47 (38.2)	38 (30.9)	4 (3.3)	3 (2.4)	123 (100)
Grand mean	87 (28.1)	137 (44.2)	69 (22.3)	12 (3.9)	5 (1.6)	310 (100)
Average cost of Setting up Local Refining camps in Naira (#)						
States	<100 T (%)	101-200T (%)	201-300T(%)	301-400T(%)	>400T(%)	**Total (%)**
Bayelsa	12 (7.1)	34 (20.2)	89 (53)	21 (12.5)	12 (7.1)	168 (100)
Delta	1 (5.3)	3 (15.8)	6 (31.6)	4 (21.1)	5 (26.3)	19 (100)
Rivers	5(4.1)	18(14.6)	27(22)	41(33.3)	32(26)	123 (100)
Grand mean	18 (5.8)	55 (17.7)	122 (39.9)	66 (21.3)	49 (15.8)	310 (100)
Average daily income from artisanal refineries in Naira (#)						
State	Categories	50-100 T (%)	101-200 T (%)	201-300T (%)	>300 T	**Total (%)**
Bayelsa	Local	40 (24)	76 (45)	25 (15)	27 (16)	168 (100)
	International	121 (72)	24 (14)	10 (6)	13 (8)	168 (100)
Delta	Local	2 (10.5)	9 (47.4)	4 (21.1)	4 (21.1)	19 (100)
	International	13 (68.4)	4 (21.1)	2 (10.5)	00(00)	19 (100)
Rivers	Local	11 (9)	26 (21)	55 (45)	31 (25)	123 (100)
	International	14 (11.4)	30 (24.4)	57 (46.3)	22 (17.9)	123 (100)

Table 4: Costs (time and money) implications and monetary benefits of running artisanal oil refinery

N: B, T represents thousand; Wk (s) represents week (s)

IV. DISCUSSION OF FINDINGS

Overall, it takes between one to two weeks to complete an artisanal refinery. The spill over is completed in the third week. This pattern did not follow in all the states. In Bayelsa State it took one to two weeks to complete an artisanal refinery. In Delta State it takes three weeks to complete an artisanal refinery while in Rivers State, it takes between two to three weeks to complete an artisanal refinery. The reason for the spatial disparity in the building of the refineries may be related to availability of the financial power of the intending investor and the lucrativeness of the business that exists in Bayelsa and Rivers State. That may not be in Delta State (Avwiri & Ononugbo 2011).

Furthermore, it is fairly cheap to erect an artisanal refinery in the area considering income in return for investment. The cost of siting an artisanal refinery fell between 201000 and 400000 naira. However, in Bayelsa State it costs 201000-300000 to site an artisanal refinery. In Rivers State, the amount of money needed to site an artisanal refinery ranged from 100000 to above 400000. Compared to the amount they can make from these refineries (though illegal), the amount needed to set it up is relatively small and can hence be sort for by intending investor (Obenade&Amangabara, 2014).

An inquiry into the daily income of the investors in artisanal refineries in the study area showed that daily income ranged from fifty thousand naira (50000) to above three hundred thousand naira. This means that the business has a reckonable return on investment, with propensity of realizing total investment in a week, albeit with health and environmental costs. The business appears to be more lucrative in Rivers state which realizes 201000-300000 daily for local sale of products, and for international sales. Conversely, Delta state had the lower income levels of about 100000-200000 daily from sale of products. According to Emuedo, Anoliefo, and Emuedo, (2014), the amount of money generated from local refining would assist in thwarting the efforts of government in criminalizing artisanal refining. In their views, rather than criminalize such endeavor, government should rather, fashion better ways of engaging in artisanal refining that won't undermine the health and environment of man. This view is dissimilar

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with that of Ogele and Egobueze (2020), who asserted that artisanal refining is a product of agitation for resource control, whose methods of production undermine the very essence of existence and thus should be abrogated.

V. CONCLUSION AND RECOMMENDATIONS

The study can be concluded that the time and financial cost of running an artisanal refinery is low and thus encourages locals to invest in it. The consequence of such sporadic opening of poorly developed refineries is severe on not only those operating the refineries but, on the communities, as well. Based on this, the study recommended that government and well-meaning Nigerians should team up to chart a proper way of refining crude, which were both health for operators and locals, and more sustainable. In addition, as a matter of urgency, the Government should embark on a study of the process of artisanal refining and improve where need be in the process in order to braze-up the tide and stimulate local capacity in refining. It is also imperative for the oil companies operating in the region to collaborate with government to increase their corporate social responsibility through the encouragement and support of the development and expansion of the local economy for rural inhabitants in the study area such as provision of social and welfare amenities, and companies to engage youths.

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