

Homegrown Solution to African Problem: Harnessing Innovation for Petroleum Refining in Nigeria

Nathaniel Umukoro, Ph.D., Delta State University, Nigeria

ABSTRACT

Nigeria, a major petroleum producer and exporter, suffers from lack of refining capabilities, sometimes creating supply shortages. To satisfy demand, petroleum products must be imported from other countries. The situation is dire in areas of the Niger Delta. This has contributed to the development of artisanal refining of petroleum—a homegrown solution. Several studies have considered various aspects of this locally innovative strategy, often focusing on its environmental problems. Little attention has been given to how local refining can be harnessed to ameliorate the problems associated with petroleum shortages in Nigeria. This article examines the benefits of local, innovative refineries and argues that they be legitimized and regulated.

INTRODUCTION

The production of crude oil is Nigeria's most important source of foreign exchange and non-renewable energy. It contributes over 90% of the foreign exchange earnings of Nigeria and about 80% of capital and recurrent expenditure. The Nigerian oil industry has predominantly served the interests of both domestic and international elites. This usually results in the export of crude oil and shortages of refined petroleum products in Nigeria. Despite having four petroleum refineries, Nigeria exports crude oil but must import refined petroleum products for domestic consumption. The importation of refined petroleum products

has been associated with problems such as fuel subsidy scams. Fuel subsidies cost Nigeria large sums of money that could otherwise be used for education, health, agriculture, rural development, transport, land and housing. Given Nigeria's consumption of about 45 million liters of premium motor fuel daily, the existing refineries produce only 12 million liters daily and are unable to meet local requirements [1].

The situation is more challenging in riverine areas of the Niger Delta. This has contributed to the innovation of a locally contextualized strategy for petroleum refining, usually called artisanal refineries. Several studies on artisanal refineries in the Niger Delta have focused on their negative aspects. For example, a study conducted by United Nations Environment Program in 2008 identified artisanal bunkering and artisanal or illegal refining of petroleum as a source of environmental pollution similar to oil spills and gas flaring by oil companies. Naanen and Tolani examined the social context of illegal oil bunkering and artisanal refining in the Niger Delta and viewed the situation as a private gain and public disaster because of the environmental pollution associated with these activities [2]. Asimiea and Omokhua also examined the environmental impact of illegal refineries on the vegetation of the Niger Delta [3].

As most studies have focused on the negative aspects of artisanal refineries, the positive aspects of artisanal refining are yet to be effectively researched. This article considers the positive aspects of this innovative strategy and how it can be harnessed to ameliorate the problems of petroleum refining in Nigeria, seeking to answer the following questions:

- In what ways have locally contextualized innovative solutions to the problem of petroleum refining benefited the riverine communities of the Niger Delta?
- How can this innovative strategy be scaled up to ameliorate the problem of petroleum refining in Nigeria?
- What are the benefits Nigeria will derive from legitimizing and institutionalizing an innovative petroleum refining strategy in the Niger Delta?

These questions were answered using data from both primary and secondary sources. Primary data for answering these questions were derived through observation, interviews and focus group discussions with selected individuals engaged in petroleum refining using local approaches. Key informant interviews were also conducted with se-

lected staff of non-governmental organizations, universities and other research institutions in Nigeria. Secondary data were obtained from books, journal articles and reports. This article begins with an overview of petroleum production in Nigeria.

PETROLEUM PRODUCTION AND THE NIGERIAN ECONOMY

Prior to Nigeria's independence in 1960, about 80% of its labor force was engaged in agricultural activities. Agricultural products accounted for 85% of Nigeria's foreign exchange earnings. While Nigeria continued to be primarily an agricultural country after its independence, the increases in oil production and international crude oil prices during the 1970's led to the neglect of the agricultural sector which provided employment for majority of the population.

Petroleum Development in Nigeria

The early development of the petroleum industry in Nigeria can be traced to 1908, when the German Bitumen Corporation, started petroleum exploration activities in the Araromi area of western Nigeria. These pioneering efforts were affected by the outbreak of World War I in 1914. After the war, oil exploration resumed in 1937, when Shell D'Arcy (the forerunner of Shell Petroleum Development Company of Nigeria) was awarded sole concessionary rights for the territory of Nigeria. After years of investment and search, crude oil was discovered in commercial quantities in 1956 at Oloibiri in the Niger Delta area of Nigeria.

Production of crude oil in commercial quantities and exports from the Oloibiri field began in 1958. The initial crude oil production rate was 5,100 barrels per day (bbl/d). This occurred before Nigeria became politically independent in 1960. Oil production since Nigeria's independence has been characterized by agitations from host communities and human rights violations by the government. Scholars have documented and analyzed the confrontations that have characterized oil production which involved the host communities, multinational corporations and the government. For example, Obi studied how oil extraction and the dispossession of the people of the Niger Delta resulted in incidents of violence—clashes between rival armed groups, militias and government troops—characterized by killings, sabotage of oil pipelines and installations, and a thriving transnational trade in stolen oil (or illegal

oil bunkering) [4]. Frynas also examined the consequences of foreign oil production activities in rural communities of the Niger Delta [5]. The study gives a comprehensive overview of the environmental and social impact of oil operations which were little understood. Frynas further argued that the country's environmental and land laws, its court system, and its law enforcement methods are biased in favor of multinational oil corporations [5]. This has resulted in multiple conflicts and litigations by aggrieved persons and communities.

Ako and Okonmah asserted that oil production has made the Niger Delta a place characterized by violent conflicts that threaten both local and international economic stability and security [6]. They argue that the underlying factor for restiveness is the exclusion of the local communities from participating in the exploitation and benefits of oil production. Klieman examined how policies after Nigeria's independence contributed to violent events in the Niger Delta [7]. The study revealed how a tax battle waged by U.S. multinational oil companies contributed to regional and ethnic hostilities, leading to the outbreak of the Nigerian Civil War from 1967 to 1970, a war fought to counter the secession of Biafra from Nigeria. In the pre-war oil boom era in Nigeria, U.S. multinational oil companies commenced intensive lobbying to persuade business owners that the newly imposed Libyan-style tax laws would force them out of business. They contended that the ethnic groups residing in the regions where they operated would be relegated to perpetual poverty. This campaign thus aggravated ethnic tensions, falsely heightening the stakes over which the war was to be fought. Currently, petroleum production and export have a dominant role in Nigeria's economy and account for about 90% of its gross earnings. The overriding role of the petroleum sector in Nigeria's economy has pushed agriculture, the traditional mainstay of the economy prior to the 1960s into the background [8].

Origin of Locally Innovative Strategy for Petroleum Refining

The locally contextualized innovative strategy for petroleum refining in the Niger Delta is typically called artisanal refining. Artisanal refineries are small-scale facilities that perform subsistent distillation of crude petroleum over a specific range of heating points, producing useable products such as kerosene, fuel, diesel, bitumen and wastes. The process involves traditional knowledge and skills with little reliance on advanced technology. Artisanal refineries use a simplified version

of fractional distillation (locally called “cooking”). They cook barrels of crude oil with firewood and other mixtures in sealed tanks constructed from metal. The crude then evaporates and passes through two parallel pipes joined to the tank through a cooling water bath usually constructed with wood. The refined products then drip out slowly into a container with different products emerging at various intervals.

The yields of each product depend on the refining methods and the properties of the particular crude used. Most Nigerian crude oil grades are heavily diesel-rich. The quality of products obtained varies widely. To address this, artisanal refineries sometimes purify diesel by mixing it with kerosene to reach a large refinery standard. Artisanal refineries rely on illegal bunkering for supplies of crude petroleum, their primary raw material [2]. They typically have production capacities of about 10,000 bbl/d. The refineries are unautomated, less capital intensive and more labor intensive. They are simple, efficient and inexpensive to establish. Their relatively low initial investment cost allows indigenous private investors to readily enter the refining business [9].

The origin of the technology for artisanal refining of crude oil in the Niger Delta region is unknown. Key informants and participants in focus group discussions have different perspectives on its origins. One claim is that Biafra invented the technology for small scale refineries during the civil war to meet its refined petroleum requirements in response to blockades placed by federal forces. This technology continued to be used after Biafra’s unsuccessful bid for secession and is used presently by artisanal refineries in oil producing areas of the Niger Delta. A second claim links the technology to the illicit relationship between oil workers and idle young men in the Niger Delta who seek quick profit. Proponents of this theory believe that unknown sympathetic engineers offered the technology to locals to provide them with a means of livelihood following the collapse of their farming and fishing vocations due to oil-induced environmental devastation. Others insist that rather than an act of benevolence, it was a mutually beneficial collaboration between greedy oil workers and self-seeking local youth. Another theory claims that the practice was started by makers of a local alcoholic beverage (gin), which is made from distilling palm wine. This view asserts that local distillation technology was successfully used to refine petrol, diesel and kerosene in Nigeria [10]. The ingenuity of the palm-wine tapper was apparently sparked by the imperative of demand and supply. Needed refined petroleum products were in high demand

but with limited supply from legitimate sources. Others claim that the oil companies themselves introduced the technology in order to be able to obfuscate information regarding the real volume of oil being lifted in the Niger Delta region. Yet another account suggests that Niger Delta militants started artisanal refining because they were in need of refined petroleum products for their boats after their supplies were suspended by the government. Regardless, this supply situation is compounded by poverty and lack of access to petroleum products in the challenging and difficult terrain of the Niger Delta.

Despite the uncertainties associated with identifying the origin of the artisanal refining process, there is a consensus from those interviewed that it was likely the technology originally used for refining a local gin called ogogoro was adapted for crude oil refining. The adaptation became widespread because of the inability of people to earn adequate revenue from agricultural activities and the production of the local dry gin. This is due to the destruction of farm land, aquatic life, and the raffia palm used for producing ogogoro that resulted from oil pollution. Some of the respondents asserted that most people engaged in artisanal refining of crude oil in the Niger Delta did not set out originally to refine crude oil. They started with bursting pipelines to siphon petrol and diesel for sales. When these activities were becoming really dangerous—many people were being incinerated at the point of siphoning and arrested by security agents—they began artisanal refining activities as an alternative. According to the respondents, the government security agents in the Niger Delta did not realize that artisanal refining of crude oil was occurring. The military joint task force (JTF) initially concentrated on fighting militants. Members of the JTF were surprised to learn that militants in the mangrove forests were obtaining fuel to operate their boats and generators. It was later discovered that the militants were getting supplies of refined products from artisanal refiners. This marked the beginning of efforts to locate and destroy artisanal refineries in the Niger Delta.

These theories of the origins of artisanal refineries notwithstanding, more salience is often placed on the notion of existential exigency and the pressures placed on artisanal refiners to earn a living. Artisanal refineries respond to the perennial scarcity of petrol, diesel and kerosene in Nigeria which are used for vehicles, producing electricity and domestic cooking [11]. The need for these products is imperative due to inadequate electricity supplied from the national grid and sub-national

systems. In parts of the Niger Delta where regular consumer petroleum products cannot be easily obtained, products from illegal refineries have become indispensable. Established marketers of petroleum products are also known to patronize artisanal refined pans which they mix with products from other sources in underground tanks for filling (gas) stations, dispensing product to unsuspecting members of the public. Products from artisanal refineries are also used by industrialists who depend on electric generating plants to keep their businesses operating in the absence of a constant electricity supply. With the end of the insurgency and the commencement of the amnesty program, artisanal refining continues as a source of income for demobilized insurgents and idle Niger Delta youths. The raw materials needed are accessible and plentiful.

HARNESING THE HOMEGROWN SOLUTION

Local refining of petroleum using artisanal refining methods has increased in the past few years. Riverine communities, especially those in remote areas of the Niger Delta, have obtained steady supplies of refined petroleum products such as kerosene for the past decade from local refineries. The refined products are sold in commercial quantities to other parts of Nigeria, thus providing sources of income and employment for the teeming youths in rural areas of the Niger Delta. Participants in focus group discussions generally espoused the view that artisanal refining of petroleum fills an economic vacuum—local communities suffer from the impacts of oil extraction but see none of the economic benefits. The failure of the Nigerian government to provide basic public services and security in the Niger Delta has resulted in a breakdown of the social contract. In the face of corruption by political elites, communities view artisanal refining as means of surviving economically in the absence of mainstream livelihoods. They assert that the local refineries help balance the activities of the region's militants and pirates since thousands of jobless people participate. Key informants and participants in focus group discussions acknowledged the environmental consequences of these activities. Regardless, they view their activities as the only available option to survive the economic hardships they confront. They also feel a strong sense of ownership toward using their artisanal refining technologies and do not want to abandon their activities.

The Role of Research and Development

Empirical research and surveys of business activities show that innovation spawns new and improved products and services, higher productivity and lower product prices. Economies with consistently high levels of innovation have high levels of economic growth [12]. The experiences of economically advanced countries indicate that research and development (R&D) is crucial for harnessing homegrown innovation for sustainable development. In February 2012 Barack Obama, a former president of the U.S., stated, "We need to build a future in which our factories and workers are busy manufacturing the high-tech products that will define the century... Doing that starts with continuing investment in the basic science and engineering research and technology development from which new products, new businesses, and even new industries are formed." He emphasized that investment in technology and future capabilities is transformed into new products, processes and services. The economic growth of any nation depends on the capacity to educate, innovate, and build long-term national investments in basic and applied R&D. Mutually reinforcing and complementary investments in R&D by both the private and public sectors work in concert to support the development, production, and commercialization of new products and processes.

The benefits associated with promoting innovative activities are captured in the following statement of former U.S. president George W. Bush in 2004, "America leads the world because of our system of private enterprise and a system that encourages innovation. And it's important that we keep it that way. See, I think the proper role for government is ... to create an environment in which the entrepreneurial spirit flourishes...the Government can be a vital part of providing the research that will allow for America to stay on the leading edge of technology... I think we ought to encourage private sector companies to do the same, invest in research." Since innovation has long been recognized as an important driver of economic growth, it is pertinent that the Nigerian government learn from the experiences of countries such as the U.S. by promoting innovative R&D. National investment in R&D includes investments by governmental entities, colleges, universities, businesses and non-profit organizations.

Various institutions in the Niger Delta specializing in petroleum related activities have important roles in future R&D. These institutions include the Federal University of Petroleum Resources (FUPRE), the Pe-

troleum Training Institute (PTI), the Delta State University Department of Petroleum Engineering and the University of Benin. Key informants indicated that the artisanal refinery operators also have begun supporting R&D. They have discovered that pollution from their refining activities can be minimized by using gas cookers to heat crude oil during the refining process instead of using wood or wasted crude which often produces pollution in the form of a thick smoke.

Participants in focus group discussions and key informants from the institutions indicated that it is possible for the locally developed processes for petroleum refining to be enhanced in ways that will improve the quantity and quality of the refined products. They identified challenges for R&D associated with artisanal refining. One is inadequate research funding for educational institutions which creates difficulties for those interested in collaborating with local refiners to improve the processes. It is imperative that organizations both within and outside Nigeria assist researchers who are interested in finding ways to improve the local technologies for petroleum refining. Developed countries have demonstrated that funding innovative projects solves problems. American research universities have been a model of innovation throughout the world, addressing complex economic, social, scientific and technological problems [13]. Universities contribute to the quality of a region's economic infrastructure by developing knowledge-linking activities to enhance the commercialization of new technologies, support organizational and community change, and assure the education and competency of workers and professionals [14].

In the 1970s, China and India funded research for innovative solutions and became economic super powers. They looked inwards, finding solutions to their challenges, and implemented those that they believed would work best given their circumstances. They developed their own technologies and constructed production facilities that improved over time. Today, these countries not only provide their indigenous technological needs but also export technologies and industrial products.

The improvement of the indigenous technology for petroleum refining through R&D facilitates air and water pollution reduction. If the quality of these refineries is enhanced, the government of Nigeria can offer licenses to the entrepreneurs enabling them to engage in their activities legally. The legalization of the artisanal refineries will make it possible for the entrepreneurs to purchase crude oil at a price stipulated by the government, reducing crude oil theft by the refiners.

Economic Impact of Failing to Harness Homegrown Petroleum Refining

The inability of the Nigerian government to improve the performance of state-owned refineries has made Nigeria a major importer of petroleum products. The failure of the government to harness the ingenuity of artisanal refinery operators in the Niger Delta has adverse effects on the Nigerian state. It increases expenditures for the importation of petroleum products. Ploch observed that “Nigeria imports an estimated \$10 billion of fuel annually for domestic consumption” [15]. In 2012, “Nigeria consumed 270,000 bbl/d and in 2013, she imported slightly more than 84,000 bbl/d of petroleum products” [16]. Nigeria purchases fuel from distant countries including Venezuela, the U.S., Canada, Brazil, the Netherlands and the United Kingdom. Nigeria also imports premium motor spirit (PMS) from non-oil producing countries including the Niger Republic, Cote d’Ivoire, the Netherlands, India, Korea, Finland, Singapore, France, Israel, Portugal, Italy, Sweden, Tunisia and others [17].

Closely related to large government expenditures on imported refined petroleum products is the issue of subsidies. Studies indicate that subsidies associated with importing such products enable the embezzlement of public funds [18]. For example, a parliamentary probe in 2012, determined “that graft in the fuel subsidy scheme cost Nigeria \$6.8 billion between 2009 and 2011” [19]. If artisanal refineries are legalized, monies expended on subsidies can be used to provide health services, public works, youth employment, urban mass transit, vocational training, and infrastructure improvements, such as roads, rail, water resources and electricity.

Failing to harness the homegrown solution for petroleum refining also encourages environmental pollution in the Niger Delta that is caused by government security agents when they destroy artisanal refineries. Currently, the federal government of Nigeria uses the Joint Task Force (JTF) to fight against oil theft and the proliferation of artisanal refineries. This is not an effective long-term strategy. The JTF activities temporarily interrupt some of the refining operations, yet camp owners and workers interviewed did not view JTF’s activities as a major threat to their business. After the destruction of artisanal refineries and their products by the JTF, camp owners quickly rebuild their operations in new locations. All the respondents during focus group discussions indicated that the major concerns about the activities of the JTF are the

effects of the destruction of artisanal refineries and crude oil on the environment.

When the security forces seize crude oil and equipment used for artisanal refining there does not seem to be a safe and environmentally friendly method for disposal. Rather, they are indiscriminately burnt in the open, often in close proximity to homes and businesses. Burning of artisanal refineries and associated equipment and supplies is a JTF practice openly acknowledged in their press releases. When the JTF decides to terminate an artisanal refinery operation, all crude oil containers at the site are destroyed by combustion. The JTF also sets ablaze all confiscated tankers. Boats laden with crude oil or refined products are burnt or emptied into the waterways and wetlands with adverse environmental impacts. One respondent noted that “when the armed forces destroy artisanal refineries and the refined products thick smoke covers the skies, dangerous gases are emitted into the atmosphere thereby causing environmental pollution.”

Benefits of Harnessing the Homegrown Solution for Petroleum Refining

Improving the capacities of artisanal refineries in the Niger Delta through R&D will benefit the Nigerian government by creating additional revenue. Studies have shown that countries that increased refining capacities seem to have gained from their linkages with oil production [20]. Some may argue that since production from artisanal refineries is low, they may not notably impact in the Nigeria economy. This is not necessarily true. An analysis of Chinese national oil companies operating in Africa and central Asia suggests that new technologies enable some oil projects to operate profitably [21]. In countries such as Chad, where the French and U.S. oil companies felt that refinery projects would not be viable, oil projects have instead proved to be beneficial to the local economy [22]. A recent analysis by the International Monetary Fund found that a new refinery built by the Chinese National Petroleum Corporation (CNPC) in Chad is economically viable, providing adequate margin between the costs of production and the income from refined products [23,24].

Benefits that the Nigerian state can gain from supporting larger production volumes from artisanal refiners include increased economic diversification resulting from linkages with other firms, a more reliable supply of petroleum products, creation of new employment, reduction

of poverty and reduced income inequality. More refineries are needed in Nigeria for strategic reasons. They will help improve the nation's gross domestic product.

Since the Nigerian government is advocating increased participation in agricultural activities, harnessing the homegrown solution for petroleum refining complements increased agricultural productivity. Farm machinery requires petroleum. The byproducts of petroleum refining are useful for agricultural purposes. Most pesticides and many fertilizers are made from petroleum. The use of chemical pesticides and fertilizers increases agricultural productivity.

Legalizing and scaling up production from artisanal refiners will foster improved security in the Niger Delta. Unemployed youths are influenced to engage in militant activities and the destruction of oil pipelines, forcing the federal government to depend mainly on the importation of refined products from other countries. Artisanal refineries offer the youth alternative employment opportunities. The frequent crises in the Niger Delta region between 2002 and 2006 paralyzed the oil sector, making Nigeria dependent on imported petroleum products. Funso Kupolokun, the group managing director of the Nigerian National Petroleum Corporation, once asserted that Nigeria depended 100% on imported petroleum products when the nation's four refineries were closed due to a damaged supply line while militants fought for local control of the Niger Delta's oil [25].

CONCLUSION

The homegrown solution for petroleum refining in the Niger Delta can be harnessed for petroleum refining in Nigeria. This requires the efforts of the Nigerian government and research institutions in Nigeria. Federal government actions to destroy the indigenous refineries should be reconsidered. Hindering development prevents operators from improving artisanal refineries. This can be improved with focused research and development.

It is also important to review extant laws on refining of petroleum products. Such laws prohibit the use of indigenous technology for petroleum refining in the Niger Delta since they are not recognized by the state as credible for licensing purposes. For example, Section 3(1) of the Petroleum Act states that no refinery shall be constructed or operated

in Nigeria without a license granted by the minister. The government through a well-articulated policy framework should formalize the activities of the indigenous refineries by licensing their operations in Nigeria.

Rather than signing agreements with foreign countries to establish modular refineries (as Nigeria did with the U.S. in 2012), the government should harness homegrown solutions to oil refining, creating more petroleum products in the Niger Delta. If the local refiners are encouraged, the government could work with them and sell crude to them for refining. Legitimizing this type of strategic engagement could end petroleum theft, reduce environmental pollution and create more employment opportunities.

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ABOUT THE AUTHOR

Dr. Nathaniel Umukoro holds a Ph.D. in peace and conflict studies from the University of Ibadan, Nigeria. During his doctoral studies, he was a fellow of the next generation social sciences in the Africa program of the Social Science Research Council, New York. He is also an alumnus of Brown International Advanced Research Institute, Brown University, U.S. and the George Eckert Institute, Germany. He has published over 30 journal articles and chapters in books. He specializes in security and strategic studies with regional focus on Africa. Nathaniel Umukoro is currently a senior lecturer in the department of political science, Delta State University, Abraka, Nigeria.