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Empirical investigation of challenges of distribution of premium motor spirit (PMS) in Federal Capital Territory (FCT), Abuja and environs, Nigeria

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Abstract

Petroleum products are an important source of energy globally. Therefore, effective running of any economy depends on the efficient and sustainable supply of these products. In particular, premium motor spirit (PMS) is the most important energy source to power vehicles. Disruption in supply of this critical resource in Nigeria has been a recurring problem as its distribution is beset with multitude of problems. This paper investigated the effects of four of these problems on the supply and scarcity of PMS in the Federal Capital Territory (FCT), Abuja and environs. In addition to the review of related literature, primary data was obtained from a valid sample of 171 respondents in petrol stations in the study area. The analysis of data was undertaken through Pearson Product Moment Correlations. The analysis showed that all the independent variables (low refining output, inadequate pipeline infrastructure, pipelines vandalism and rupture and bridging of petrol through road transportation) significantly affect PMS supply and cause scarcity of the product in the FCT and environs. Inadequate pipeline infrastructure has the greatest impact on PMS supply. Based on these findings, we concluded that regular supply of PMS in the FCT and environs is plagued by the four problems investigated in this paper. A number of policy implications and recommendations of the findings of the paper were highlighted, and future research direction was suggested.

Keywords: Challenges, premium motor spirit, distribution, Federal Capital Territory and Nigeria.

1. Introduction

Agriculture was the cornerstone of the Nigerian economy before the discovery of oil in Nigeria, supplying bulk of the government revenue and foreign exchange needs of the country. However, the oil discovery in large and commercial quantity in 1956 in current Bayelsa state (Dharam, 1991) led to the neglect of the sector by successive governments (Okusaga & Aminu, 2012), leading to the change in the economic template in the country (Cole & Aminu, 2012). Since the discovery, petroleum industry has been the mainstay of the Nigerian economy (Aigbedion & Iyayi, 2007). For example, it is estimated that crude oil accounts for 95 per cent of the Nigeria's foreign exchange earnings and about 65 per cent of the federal government's revenue (Akpoghomeh & Badejo, 2006). The oil industry in the country is huge and critical to the day to day functioning of the economy.

The petroleum industry consists of two major activities, the upstream and the downstream activities. The upstream includes exploration, production and transportation of crude oil and gas to the point of refineries, where they are transformed into refined products. The downstream activities deal with the processing of crude oil into the refineries, the distribution and marketing of all the petroleum products (Aigbedion & Iyayi, 2007; Manzano, 2005; Tordo, Tracy, & Arfaa, 2011). Combined together, these activities commonly referred to as upstream and downstream petroleum sectors are important to the smooth running of every economy because they provide energy and energy-related products that are the bedrock of the economy. The present study is concerned with the downstream sector.

The importance of petroleum products to all facets of human activities around the globe cannot be over-emphasised (Masseron, 1990; Odularu, 2007; Yergin, 1991). As a result, effective running of any economy depends on the efficient and sustainable supply of petroleum products (e.g. PMS, diesel, kerosene, etc.). In line with this, oil is seen as a major source of energy in Nigeria and the world in general (Odularu, 2007), and a failure to supply it can paralyse the economic activity of a country (Varma, Wadhwa, & Deshmukh, n.d.). Consequently, its consumption is inevitable and the demand for it is ever increasing in the country and elsewhere. In Nigeria, demand for petroleum products has been driven by economic growth, increase in vehicular traffic, and inadequate supply of electricity (Asaolu, Awe, & Sholotan, 2010). Unfortunately, in spite of increasing supply of the product to meet the growing demand, perennial fuel scarcity is a common feature of the Nigeria's petrol market (Akpoghomeh & Badejo, 2006; Ogunbodede, Ilesanmi, & Olurankinse, 2010; Paki & Ebienfa, 2011).

The shortage of petroleum products persists in spite of high estimates of the Nigeria's proven oil reserves of between 32 and 37.5 billion barrels of crude oil reserves and 192 trillion cubic meters of natural gas (Egbogah, 2010). This situation has been described as a paradox (Adenikinju & Falobi, 2006; Akpoghomeh & Badejo, 2006). These studies have lamented that it is a paradox that despite Nigeria being a leading member of the organisation of petroleum exporting countries (OPEC) with a large reserve and production of oil, supply of all petroleum products in the country is erratic and has fallen drastically in recent years. Ehinomen and Adeleke (2012) lamented that distribution of petroleum products in the country is hampered by multitude and complex problems causing scarcity and inflated prices of the products. Some of these problems are investigated by this study, with evidence from FCT and its environs. FCT is the administrative capital of Nigeria and according to Nigerian National Petroleum Corporation (NNPC, 2012a) accounted for four per cent of PMS distribution in Nigeria in 2012.

A number of problems affect the distribution of PMS in Abuja and other states, causing scarcity of the product. The major challenge could be traced to the moribund state of the nation's four refineries (Adenikinju & Falobi, 2006; Aigbedion & Ajayi, 2007; Akpoghomeh & Odili, 2000; Eme, 2012). The combined installed capacity of the four refineries (Port Harcourt Refinery Company, PHRC I and II, Warri Refinery and Petrochemical Company, WRPC and Kaduna Refinery and Petrochemical Company, KRPC) is 445,000 bpd (NNPC, 2010a; OPEC, 2012). With this output, Nigeria, in the past, was able to meet the local demand (Adenikinju & Falobi, 2006) and exported the excess to neighbouring West African nations. As a result of poor maintenance, theft, and fire, none of these refineries is currently operating at an optimal level (Aigbedion & Ajayi, 2007; Akpoghomeh & Odili, 2000; Eme, 2012). The capacity utilisation is estimated to be at less than 20 per cent (NNPC, 2014 as cited in Punch, 2014; OPEC, 2013). Inevitably, the failure of these refineries to operate optimally has led to frequent and sometimes perennial shortage of petroleum products, especially PMS in Abuja and the entire country.

Furthermore, the pipeline networks for PMS and other petroleum products in the country are grossly inadequate to serve the large geographical area like Nigeria. Petroleum products are transported through the length and breadth of the country by Pipelines and Product Marketing Company (PPMC) from the refineries/import-receiving jetties to 22 storage depots nationwide via 5,001 kilometre (km) multipurpose pipeline networks (Adenikinju & Falobi, 2006). Obviously, the limited pipelines infrastructure has made PMS supply to FCT inefficient. Beside the low density of this critical infrastructure, they also remain in bad shape with vandalised and ruptured pipes, thus resulting in epileptic and low capacity utilisation. The high prevalence of pipelines vandalism in the country has compounded the epileptic supply of petroleum products in the entire northern region of the country. For example, it was reported that 80 per cent of the pipelines network in the country have been vandalised (Momoh, 2014 as cited in Eboh & Eboh, 2014). Closely related to the above is the problem of transporting PMS through trucks from depots to retail outlets. Loading from 22 depots implies that trucks have to cover several kilometres of poorly maintained road networks to discharge PMS to several retail outlets in FCT and environs. The delay caused by this long haulage and sometimes road accidents involving these trucks may cause PMS shortage in the nation's capital and other States in the North. Workers in the oil sector have expressed their displeasure over the bad state of roads through industrial actions. The recent warning strike in December, 2014 was one of such actions to draw the government's attention to the poor state of the roads.

It is therefore, pertinent to investigate the extent to which these problems have caused the scarcity of PMS often experienced in FCT and environs. While a large body of research on downstream petroleum sub-sector in the country has been done on deregulation of the sector and removal of subsidy (Adagba, Ugwu, & Eme, 2012; Eme & Onwuka, 2011;

Godwin, Iheanyichukwu, Uranta & Elemanya, n.d.; Odeh, 2011; Onyishi, Eme, & Emeh, 2012; Ugwu, Okpaga, & Eme, 2012), a few studies have been done in the area of supply, distribution and marketing of petroleum products (Adekeye, 2010; Adenikinju & Falobi, 2006; Akpoghomeh & Badejo, 2006; Ehinomen & Adeleke, 2012; Obasanjo, Francis, & Williams, 2014). While several of these studies are a review, adopting a general approach to the study of problems of distribution and marketing of all the petroleum products in the country, this present study is empirical, focusing on the most important petroleum product, PMS and the nation's capital, Abuja and environs. In this regard, this study will contribute to the knowledge of understanding the challenges associated with distributing PMS in FCT and environs. Consequently, this study seeks to investigate: (i)The effect of low refining output on scarcity of PMS in FCT and environs; (ii) The effect of inadequate pipeline network on scarcity of PMS in FCT and environs; (iii) The effect of frequent pipeline vandalism and rupture on scarcity of PMS in FCT; and (iv) The effect of long oil truck haulage on scarcity of PMS in FCT and environs.

The remainder of the paper is structured as follows: in section two, review of related literature is undertaken; section three examines the method of data collection and analysis; this is followed by presentation and discussion of the results; the final section concludes and discusses implications of the study.

2.1 Distribution of petroleum products

In marketing, distribution is an important element of marketing mix through which organisations add value to their products (Kotler, 2003; Pride & Ferrell, 2013). According to Pride and Ferrell (2003: 352), “”distribution focuses on the decisions and actions involved in making products available to customers when and where they want to purchase them”. Distribution is of critical importance to businesses (Boone & Kurtz, 1999) because buyers will not purchase a product unless it is readily available when and where they want to buy it (Boyd, Walker, Mullins, & Larreche, 2002). The foregoing suggests that, irrespective of the nature of the business undertaken by organisations, distribution is a necessary and important marketing function that facilitates buying and selling activities of the parties in a transaction, and when ineffectively carried out may cause scarcity of products.

With respect to oil and gas distribution, Manzano (2005) defined petroleum product distribution and marketing as activities concerned with transportation of refined fuels from the point of refinery to consumers and the sales of the fuels either in bulk or in small quantities in gas stations. Ehinomen and Adeleke (2012: 235) defined petroleum product distribution as "concerned with the movement of refined petroleum from refinery to the final consumers across various locations of delivery in the country". In consistence with this definition, Furchtgott-Roth (2013) argued that crude oil and refined products will have to travel to where it is needed, noting that irrespective of where it is produced, it will be used all over the country. This is also the case with oil and gas in Nigeria. For example, the crude oil that is produced in the Niger Delta region of Nigeria will need to move to refineries in Port-Harcourt, Warri and Kaduna where it will be processed into petroleum products; petroleum products will, in turn, have to be transported to all the 22 storage depots in different regions of the country, where it will be loaded into trucks for onward distribution to retail filling stations across the country. PPMC is a government agency charged with the responsibility of wholesale supply, distribution and marketing of petroleum products in the country.

Prior to the construction of refineries in Nigeria, distribution and marketing of petroleum products used to be exclusively handled by few multinational oil companies until 1973, when the federal government got involved. Akpoghomeh and Badejo (2007) provided the historical antecedents of distribution and marketing of petroleum products in the country that the absence of pipeline networks during the period of petroleum products importation in 1970s made the companies involved in the products distribution rely on trucks to transport the products from import-receiving jetties to their depots and onward to retail outlets. However, this changed with the establishment of the refineries and construction of network of pipelines that crisscrossed the entire country.

Therefore, pipelines remain the most popular, efficient and effective distribution means of distributing petroleum products (Furchtgott-Roth, 2013; Manzano, 2005; Varma et al.,

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n.d.). Gas, crude oil and refined products are distributed (transported) via pipelines, rail, road, and sea (Akpoghomeh & Badejo, 2007; Ehinomen & Adeleke, 2012; Ogwu, 2011 Furchtgott-Roth, 2013; Manzano, 2005; Ogwu, 2011), with pipelines accounting for about 50 to 60 per cent of the total volume transported in developed countries (Varma et al., n.d.). Pipeline infrastructure is critical in the petroleum product production, transportation, storage

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Area											
Port Harcourt (Sys. 2E, 2EX)	16	33	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	24
Warri (Sys. 2A, 2C, 2CX)	14	25	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	2
Mosimi (Sys. 2B)	8	5	15	6	20	14	Nil	7	5	2	2
Kaduna (Sys. 2D)	19	12	6	Nil	Nil	19	4	15	14	24	33
Gombe (Sys. 2D)	1	1	Nil	3	Nil	Nil	23	2	Nil	Nil	4
Total	48	76	25	9	20	33	27	24	19	26	65

… Nigeria (Ogwu, … rosene and PMS … distributed in the … contrast to almost … th, 2013). PPMC, a marketing subsidiary of NNPC, regulates the network of pipelines and depots in the country (PPMC, 2010b).

Road mode (bridging) is also used to transport petroleum products in the country, with modal share increasing to between 78 and 82 per cent due to the rising oil pipeline vandalism and inefficient railway system in the country (Akpoghomeh & Badejo). In the U.S., rail and road are used to distribute oil and gas products in the regions where the supply of pipeline infrastructure is limited; for instance, in the Midwestern states, rail mode is used to transport oil from North Dakota to refineries, and in Cushing, Oklahoma, rail is used to transport oil out of the distribution center (Millican, 2013). India relies more on the rail mode of transportation to distribute petroleum products, accounting for about 40 per cent of total modal share (Varma et al., n.d.). Poor maintenance of the Nigerian railway system has made it unreliable to move petroleum products across the country (Akpoghomeh & Badejo, 2007). In addition to pipelines, marine tankers numbering about 20 are also used in the country to transport petroleum products from the coastal refineries of Warri and Port-Harcourt to Lagos metropolis (Ehinomen & Adeleke, 2012).

2.2 Challenges militating against PMS distribution in Nigeria

There are a number of challenges bedeviling smooth flow of petrol products in FCT and the rest of the country. Four of these challenges are reviewed in this section and include low refining output of the nation's refineries, inadequate pipelines infrastructure, pipelines vandalism & rupture and high prevalence of trucks to transport petroleum products.

2.2.1 The challenge of low refining output of the refineries in Nigeria

Petroleum refineries are large factories that convert a raw material, crude oil, into commercially valued products (American Petroleum Industry, 2006). The petroleum refining industry is the largest source of energy products in the world, transforming crude oil into gasoline, diesel, jet fuel, and other hydrocarbon products that can be used as either feedstock or energy source in chemical process industry (Shah et al., n.d.). These definitions indicate that refineries are a critical and huge infrastructure required to process and convert crude oil into finished petroleum products in forms that can be used by final consumers and industrial users and add social and economic benefits. In this regards, refining process is seen as a value-added process, which turns "the extracted hydrocarbons into usable products" (Tordo et al., 2011: 14).

A barrel of crude oil is equal to 42 U.S. gallons, 35 imperial gallons or 159 litres (Energy Information Administration, EIA, 2013; Petroleum Product Pricing Regulatory Agency, PPPRA, 2014). There are 45 gallons of petroleum products in one barrel (42 gallons) of crude oil, which consist of four gallons of liquefied petroleum gas (LPG), 19.5 gallons of gasoline, 10 gallons of diesel fuel, four gallons of aviation fuel, two-and-half gallons of fuel oil and five gallons of bottoms (Agbon, 2012). Therefore, a barrel of refined petroleum products contains more gallons of PMS than any other petroleum product, making it the most important.

The amount and stability of petroleum products supplied by local refineries is a major determinant of the effectiveness of distribution of these products in the domestic markets. For example, India has 18 refineries (17 in the public sector and one in the private), all of which are operating at a high capacity, resulting in the country being both self sufficient in the supply of finished petroleum products and able to export the excess products to foreign countries. This is in spite of the fact that the country imports 70 per cent of crude oil (Varma et al., n.d.). This has made India to have the highest refining capacity in the world, with the average capacity per refinery in the country exceeding over 100% (Purvin & Certz Inc., 2008). The rising demand for petroleum products in India and other Asian countries are promoting high capacity in the country (A.T. Kearney, 2012).

Australian refineries' capacity is also high at over 70 per cent capacity in Asia-Pacific. According to Australian Institute of Petroleum (2012: 16), "Australia currently enjoys a high level of liquid fuel security and this position is not expected to change in the coming years". Among other reasons, the Institute attributed this position to the refining capability of the country's seven domestic refineries to refine about 74 per cent petroleum products in 2010-2011 to serve the needs of major industries and the fuel distribution network of about 6,300 service stations in the country.

In Africa, Ghana also imports 70 per cent of its crude oil from Nigeria but unlike India it has just one refinery, Tema Oil Refiner, which refines 70 per cent of local petroleum product needs (Coady, El-Said, Gillingham, Kpodar, Medas, & Newhouse, 2006). Though the refining capacity of the Tema refinery is not as high as the capacity of refineries in India and U.S., credit should be given to the managers of the refinery for achieving such a high capacity in a region (West African region) where refining capacity has been generally low, thus relying on imported petroleum products. For instance, it was stated that the refining capacity utilisation of all the 42 refineries in Africa averaged 24.11, 10.9 and 21.53 per cent in 2008, 2009 and 2010 respectively (NNPC, 2014 as cited in Punch, 2014). The refining capacity utilisation of both Egypt and South Africa is also high. Egypt operates at 81 per cent of 774, 900bpd capacity while South Africa operates at 85 per cent of 540, 000 capacity (Punch, 2012).

Table 1 below shows that most OPEC members also have high refining capacity and refine their petroleum products locally, thus guaranteeing smooth and regular supply of

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refined products from local refineries. For example, OPEC members, on average, can refine one-third of their production locally, with countries such as Algeria and Venezuela having the capability to process up to 70 per cent while Kuwait can refine up to 60 per cent of their domestic production in their own refineries (Siebert & Rauscher, 1985). The refining capacity in Venezuela as at the end of 2012, as shown in table 1 below, has increased to over 100 per cent of the installed capacity (OPEC, 2013). Table 1 below provides the OPEC members' fundamentals as relate to refining capacity and output and local demand.

Table 1: OPEC members' fundamentals as at December, 2012

Country	Population (million)	Crude oil Prodn (b/d)	No of refineries	Refinery capacity (b/d)	Refinery output (b/d)	Oil demand (b/d)
Algeria	37.8	1,200,000	5	694,400	451,500	351,000
Angola	18.58	1,704,000	1	37,500	38,700	94,000
Ecuador	15.50	504,000	7	188,400	132,900	264,000
Iran	76.52	3,740,000	9	1,681,000	1,774,800	1,765,00
Iraq	34.21	2,942,000	12	806,000	580,400	803,000
Kuwait	3.82	2,978,000	3	936,000	1,057,000	377,000
Libya	6.41	1,450,000	5	380,000	149,200	236,000
Nigeria	167.0	1,954,000	4	445,000	82,400	344,000
Qatar	1.77	734,000	1	80,000	122,700	126,000
Saudi Arabia	29.20	9,763,000	8	2,107,000	1,929,100	2,873,000
UAE	8.39	2,652,000	5	471,300	454,300	638,000
Venezuela	29.5	2,804,000	10	1,523,600	1,568,700	786,000

Source: 2013 OPEC Annual Statistical Bulletin (ASB). Available online at www.opec.org

Table 1 shows that Nigeria is the most populated country and the 7th largest oil producer within the OPEC. However, the number of its refineries (four) is small in relation to its massive population and compared to the population of members of the cartel. For example, Saudi Arabia, with population of over 29 million people has eight refineries; Iraq, with over 34 million people has more than 12 refineries; and Venezuela, with 29.5 million inhabitants, has 10 refineries. Interestingly, Angola and Qatar have one refinery each that produces output that is above the installed capacity. In Nigeria's case, the performance of the nation's four refineries in relation to its installed capacity and refineries in all the OPEC member countries is abysmal. The refineries, with installed capacity of 445,000 b/d, regrettably produced 82,400 bpd in 2012, representing a paltry 18.5 per cent of the installed capacity and about 24 per cent of the 344,000 b/d local demand. This is the lowest refining capacity within the OPEC and can therefore, be considered as despicable and portrays the country as incapable of maintaining the critical infrastructure necessary to support its industrialisation drive.

This is in contrast to refineries in Angola and Qatar that produced above the installed capacity and refineries in Kuwait, Iran and Venezuela that produced above both the installed capacity and local demand and exported the excess output (OPEC, 2013). Similarly, refineries in Saudi Arabia and U.A.E. produced at high capacity of their installed capacity and imported the shortfall of the petroleum products (OPEC, 2013). Nigeria appears to be the only odd country in the 12-member cartel; the only country that relies heavily on import to meet its local needs for petroleum products (Adenikinju & Falobi, 2006; OPEC, 2000).

Consequently, Nigeria, with its moribund refineries, operates at a low level of their installed capacity (Eme, 2011; OPEC, 2013; Paki & Ebienva, 2011). A number of factors have plagued the operations of the refineries. These factors include poor and non-maintenance of facilities, lack of funds and corruption (Adenikinju & Falobi, 2006; Aigbedion & Ajayi, 2007; Bello, 2012; Eme, 2012; Adagba, Ugwu, & Eme, 2012). Momoh (2014) regretted that the refineries are currently producing 10.5 millions of 40 millions of the daily PMS required. It is believed that even if all the four refineries are operating optimally, the output would still no be sufficient to meet local demand (Mohammed, 2014 cited in Akowe, 2014; Richard, 2012). Specifically, Richard opined there would still be a short gap of 15 million litres per day. This suggests Nigeria requires additional refineries to produce sufficient output for local and export markets. However, this perception is negated by the statistics provided by OPEC (2013) in table 1 above, which shows that Nigeria requires 340,000 bpd of PMS, which is lower than the 445,000 bpd installed capacity of the four refineries. In particular, Kaduna Refining and Petrochemical Company, which is to supply PMS and other products to the north including the FCT is operating at a low capacity of 1.2 mpd (Okafor, 2013).

Therefore, the perennial fuel supply crisis experienced in the FCT and other parts of the country is due mainly to the failure of these refineries to operate optimally. Therefore, we hypothesise thus:

H_1: The low output of the Nigerian refineries significantly causes scarcity of PMS in the FCT and environs.

2.2.2 The challenge of inadequate pipeline infrastructure in Nigeria

An important determinant of a regular and uninterrupted flow and supply of petroleum products anywhere in the world is the adequacy and effectiveness of pipeline network. This is because pipelines can move large volume of refined products (Bjornmose, Roca, Turgot, & Hansen, 2009), thus making it possible for the products to be promptly distributed to the nook and crannies of the market. In Nigeria, the role of pipeline network in the process of refining, storage, distribution and marketing of petroleum products cannot be overemphasised. According to Adenikinju and Falobi (2006), PMS and other petroleum products are distributed through pipelines from the nation's refineries/import receiving jetties to the 21 storage depots located in different locations in the country. The pipeline network covers an estimated distance of 5,001 km (Adenikinju & Falobi, 2006; Onuoha, 2012). Eke and Enibe (2007) identified locations of these depots as Aba, Enugu, Makurdi, Yola, Benin, Ore, Mosimi, Satellite town in Lagos, Ibadan, Ilorin, Suleja, Minna, Jos, Gombe, Maiduguri, Kano and Gusau. Two types of pipeline are common in the distribution of oil and oil products in Nigeria; they are dedicated pipelines for crude oil distribution and multi-product pipelines for refined products (Adenikinju & Falobi, 2006). The multi-product pipelines are used to move products from the refineries/import receiving jetties to the 22 petroleum storage product depots (Adenikinju & Falobi). The 5,128km of pipelines network is connected to 21 loading depots and 19 pumping stations in the country (Okafor, 2012).

In spite of the cost-effectiveness of pipelines for the distribution of petroleum products (Indicus Analytics, 2009; Moses, 2012) and being the safest distribution mode for oil and gas (Furchtgott-Roth, 2013), pipeline density of 5,001 km in the country is ridiculously limited and therefore grossly inadequate to guarantee smooth and uninterrupted supply of petroleum products in the country. This is in contrast to over 500,000 miles (804,500 km) of pipeline network in the U.S. (Furchtgott-Roth, 2013), 415,152 km in Alberta Province in Canada (Alberta Energy Regulator, AER, 2013) and 51,496 km in India (Petrotech, 2012). Within OPEC, Saudi Arabia with a population of less than 30 million has a pipeline network length of over 9,000 miles (over 14,481 km, EIA, 2013). Expansion, operation and maintenance of pipelines in Nigeria have been marred by poor funding, erratic electricity supply, corruption, vandalism and corrosion (Moses 2012; Tordo et al., 2011). Thus, we state the following hypothesis:

H_2: Inadequate pipeline infrastructure in Nigeria significantly causes scarcity of PMS in the FCT and environs.

2.2.3 The challenges of pipeline vandalism and rupture in Nigeria

There is high incidence of pipeline vandalism in Nigeria (Ashby, Ahemba, & Shirbon, 2006; Onuoha, 2008; Vidal, 2011) compared to the incidence in other countries. For example, Onuoha (2008) identified the trio of oil bunkering, pipeline vandalism and oil terrorism as the main dimensions of oil pipeline sabotage in the country and warned that unless the government makes concerted efforts to curb the rising scourge, its capacity to guarantee energy security would be compromised. According to NNPC (2012), vandalisation of oil pipeline facilities remains the critical challenge facing the industry. It noted that of the 16,083 pipeline breaks that took place in the past 10 years, vandalism by people it described as unpatriotic Nigerians accounted for a wanton 16,685 breaks, representing 97.5 per cent of the breaks. It further reported that the remaining 398 breaks, representing 2.5 per cent was accounted for by ruptures.

Table 2 below gives statistics on the pipeline breaks in the country for the period 2003 to 2013.

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Table 2: 10-year incidences of pipeline break in Nigeria (2003-2013)

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Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
P/Harcourt (Sys. 2E, 2EX)	608	396	1017	2,091	1631	557	382	142	336	393	382
Warri (Sys. 2A, 2C, 2CX)	90	241	769	662	306	745	280	161	548	495	280
Mosimi (Sys. 2B)	70	147	194	480	459	516	605	184	463	479	605
Kaduna (Sys. 2D)	11	110	237	176	126	110	100	240	571	622	100
Gombe (Sys. 2D)	Nil	1	20	265	702	357	86	109	850	241	86
Total	779	895	2,237	3,674	3,224	2,285	1,453	836	2,768	2,230	1,453

Source: 2012 and 2013 NNPC Annual Statistical Bulletin (ASB). Available online at http://www.nnpcgroup.com/public relations.

Table 2 shows a rising trend in the incidences of pipeline breaks from 2003 to 2012. The most vulnerable and affected pipelines up to 2012 are Systems 2E and 2EX in Port Harcourt and 2A, 2C and 2CX in Warri both of which are in the highly volatile and violent Niger Delta area of the country. It was found that failures of pipelines due to third party activities (sabotage) is significant in the Niger Delta area (Achebe, Nneke, & Anisiji, 2012). The youths of the area had been restive for years and engaged in violent and destructive activities in response to the failure of the government to develop the area (Aminu, 2013a; Oteh & Eze, 2012). For example, Ogwu (2011: 41) bemoaned that “the same pipelines that bring oil wealth and supply petroleum products to other regions of the country is causing untold havoc in the Niger Delta”. Consequently, the area has witnessed more pipeline attacks than any area in the country (NNPC, 2012).

As the table indicates, pipeline vandalism is not limited to the Niger Delta area but is widespread across the length and breadth of the country. Of particular interest to this study is the System 2B in the south-west. Owing to the unyielding and increasing activities of the vandals in the south-west, table 2 shows that System 2B overtook those of Systems 2E and 2EX in Port Harcourt and 2A, 2C and 2CX in Warri to become the most compromised. System 2B supplies a large portion, about 11 millions litres (Okafor, 2012; Yusuf, 2014) of the 40 millions litres of PMS required in the country. Okafor noted that System 2B pipeline located at Arepo, Ogun state provides major supplies of PMS to the south-west and the

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north. Therefore, any disruption to System 2B line will affect PMS availability in the FTC and environs. There is consensus that unemployment, poverty, hunger, greed and politically-induced reasons are some of the factors fueling pipeline vandalism in the country (Ashby et al., 2006; Oluwatuyi & Ileri, 2013; Oteh & Eze, 2011; Vidal, 2011).

Inevitably, pipeline vandalism has a number of dire consequences for the Nigerian economy and people. These include product loss, financial loss, environmental degradation, health hazards and loss of life (NNPC, 2012: Okafor, 2012; Yusuf, 2014). Table 3 below provides statistics on colossal product loss stemming from the act of vandalism.

Table 3: 11-year pipeline products loss in Nigeria (2003-2013) in '000 metric tons

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Area											
Port Harcourt	225.81	150.32	337.17	336.23	95.62	151.15	0.00	0.00	0.00	5.39	2.23
Warri	27.93	73.18	145.14	16.00	0.00	22.36	0.00	45.93	14.37	0.00	16.86
Mosimi	109.05	156.94	146.16	183.40	141.52	12.96	110.38	144.50	127.39	163.22	268.76
Kaduna	0.20	3.16	16.57	0.00	5.10	5.13	0.00	3.99	16.06	13.06	39.62
Gombe	0.14	13.29	16.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Total	**363.13**	**396.88**	**661.81**	**535.62**	**242.23**	**191.62**	**110.38**	**194.42**	**157.81**	**181.67**	**327.48**

Source: 2012 and 2013 NNPC Annual Statistical Bulletin (ASB). Available online at http://www.nnpcgroup.com/public relations.

The table shows that the total product loss within the 11-year period amounted to 3,035,897 metric tons. This translates to 4,071,138, 454 litres (where one metric ton is equal to 1,341 litres). According to NNPC (2010) the lost volume as at 2010 is almost the total volume, 4.6 billion litres consumed in the entire 1995 and more than one-quarter of 17.1 billion litres consumed in 2010. In terms of financial loss, NNPC (2012) regretted that pipeline vandalism within same period cost the nation a whopping over N174.96 billion in product losses and pipeline repairs. In terms of its implication for product distribution and supply, it has a severe consequence, contributing to the incessant fuel shortage and scarcity witnessed in the entire country including FCT (Akpoghomeh & Odili, 2000; Akpoghomeh & Badejo, 2006; Anifowoshe et al., 2011; NNPC, 2012; Oluwatuyi & Ileri, 2013; Onyishi et al., 2012; Paki & Ebienva, 2011).

According to Akpoghomeh and Odili (2000), oil pipeline vandalism/sabotage is the most disturbing threat to the regular supply and distribution of petroleum products in Nigeria and one of the causes of the perennial fuel scarcity in many parts of Nigeria. Akpoghomeh and Badejo (2006) regretted that past pipeline vandalism resulted in market volatility and scarcity nationwide. Similarly, Anifowoshe et al. (2011) noted that two of the consequences of pipeline breaks are product loss and inferno. NNPC (2012) also lamented that the existence of illegal bunkering, pipeline vandalism and product theft has largely constraint the capacity of the nation's oil and gas facilities such as depots to function optimally. In addition, Oluwatuyi and Ileri (2013) posited that the nefarious activities of the vandals in the country have led to severe product shortages in the nation's depots. The foregoing affirms that the high incidence of pipeline vandalism in the country compromises the integrity of the pipelines by causing disruptions in product flow, causing PMS shortage in the entire country, including Abuja.

Closely related to the challenge of large scale pipeline vandalism is pipeline rupture, which also causes loss of PMS and other petroleum products in the country. Unlike pipeline vandalism, pipeline ruptures are caused by aged pipes, mechanical problem, corrosion, inadequate monitoring, natural disasters, poor maintenance and accident (Achebe et al., 2012; Anifowoshe et al., 2011; Vidal, 2011). According to Vidal, many pipelines are now 40 years old, causing heavy corrosion and leakage of gas and oil. He noted further that construction firms accidentally rupture pipelines during land clearing for development. Okafor (2012) reported that people have blamed the frequent incident of fire outbreak resulting from the activities of the vandals for the rupture of pipelines. Achebe et al. (2012) found that pipeline failures in the Niger Delta area were due to 18 per cent corrosion, which was found to relate to the age of the pipelines. Ogwu (2011) cited Niger Delta Development Commission (NDDC, 2011) as noting that irregular monitoring of pipelines, after the initial construction, compromises the integrity of the pipelines and safety of people in the vicinity.

Table 4 below provides a snapshot of the incidences of pipeline rupture in the country between 2003 and 2013.

Table 4: 11-year incidences of pipeline rupture in Nigeria (2003-2013)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Area											
Port Harcourt (Sys. 2E, 2EX)	16	33	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	24
Warri (Sys. 2A, 2C, 2CX)	14	25	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	2
Mosimi (Sys. 2B)	8	5	15	6	20	14	Nil	7	5	2	2
Kaduna (Sys. 2D)	19	12	6	Nil	Nil	19	4	15	14	24	33
Gombe (Sys. 2D)	1	1	Nil	3	Nil	Nil	23	2	Nil	Nil	4
Total	48	76	25	9	20	33	27	24	19	26	65

Source: 2012 and 2013 NNPC Annual Statistical Bulletin (ASB). Retrieved from http://www.nnpcgroup.com/public relations.

Though the incidence of ruptured pipes is very low when compared to that of vandalism, it results in product loss with its negative impact on product supply. NNPC (2012) estimated that ruptured pipelines account for 2.5 per cent of product loss in the country. System B pipeline has more incidence of pipeline rupture (NNPC, 2012), and this may have a negative effect on the supply of PMS to the south-west and the north. Therefore, taken the two incidences together, we hypothesise that:

H_3: High incidences of pipeline vandalism/rupture in Nigeria significantly cause scarcity of PMS in the FCT and environs.

2.2.4 The challenge of transporting PMS through trucks in Nigeria

Transportation of petroleum products by road is most common around the world (Bersani, Minciardi & Sacile, 2010; Tordo et al., 2013). This is especially when there is inadequate pipeline network in a country or state (Millican, 2013). For example, insufficient pipeline infrastructure in North Dakota, U.S. has made the use of alternative transportation mode such as rail or road inevitable in the state (Millican). In Nigeria, inadequate pipeline infrastructure and frequent vandalism of the limited pipelines have led to the shift in the emphasis from distribution through pipeline to distribution through road otherwise known as bridging (Adenikinju & Falobi, 2006; Akpoghomeh & Badejo, 2006; Akpoghomeh & Odili, 2000; Ehikwe & Ngwoke, 2013). For example, Akpoghomeh and Badejo affirmed that the rising spate of oil pipeline sabotage has led to the reliance on bridging, accounting for between 78 and 82 per cent of domestic consumption in terms of volume in contrast to less than 4 % used in the U.S. (Freese, 2007). Ehikwe and Ngwoke lamented that the incessant vandalism of pipelines in the south-east has crippled the two depots in Aba and Enugu, forcing the marketers to rely on petrol tankers to move petroleum products from far and wide. They concluded that this impedes smooth supply of the product. Similarly, Adenikinju and Falobi explained that PPMC resorted to trucking to ensure continuous availability of petroleum products, noting that petroleum products are transported from the southern depots to other parts of the country.

"The delivery of petrol products to service stations is generally performed using tank trucks travelling from a regional central distributor to one or more service stations with an average distance of about one hundred kilometres for each trip" (Bersani et al., 2010: 130). In Nigeria, an estimated 5,000 fuel tankers are involved in the transportation of 150 million litres of petroleum products by road on daily basis (Olagunju, 2011 as cited in Obasanjo et al., 2014), which Momoh (2014) decried as inadequate. These trucks travel several hundreds of kilometres to Abuja and far north hauling petrol (National Mirror, 2012), causing delay in petrol delivery in the north (Obasanjo et al., 2014). Regrettably, transportation of petroleum products by train and trucks are much more expensive and risky (Masseron, 1990; Millican, 2013; Moses, 2013; Tordo et al., 2013). In particular, trucking costs are perceived to rise significantly with distance, making trucking the most expensive mode of petroleum transportation and impracticable to move a large volume of products over a long distance (Moses, 2012). For example, the maximum volume of PMS that a high capacity tanker can carry in Nigeria and most countries is 33,000 litres. Beside the high costs of transporting PMS via petrol tankers, it also creates supply bottlenecks in Nigeria due to poor road maintenance and frequent accidents of the fuel tankers (Adenikinju & Falobi, 2006; Ehinomen & Adeleke, 2012). These studies suggest that poor road conditions, frequent truck breakages on the road and spillage of petrol may constitute a major threat to the regular and timely supply of PMS to retail outlets in the FCT and environs.

According to the Central Bank of Nigeria (CBN, 2003), the total road network in the country is estimated at about 194,000 km. It decried the poor state of the roads, which are characterised by potholes, washing away of pavements and fallen bridges. It concluded that these problems have made it difficult, expensive and more arduous to move products and services from producers to consumers. Obasanjo et al. (2014) found that bad road in Nigeria is one of the three leading constraints to haulage of petrol in the northern region of the country. Petrol tanker accidents are common in oil-rich Nigeria, Africa's most populous nation where fuel is distributed with trucks on poorly maintained roads (African Review, 2010). The current rate of petroleum tanker accidents in the country have sent shivers down the spine of most Nigerians (Shosanya, 2012). The consequence of poorly maintained pipelines is that trucks travel hundreds of kilometres, especially from the northern states, to lift fuel from the Lagos seaport (National Mirror, 2012). It can be deduced that the delay or loss of petrol consignment through spillage, occasioned by these frequent accidents may affect the smooth supply of PMS in FCT and environs. Therefore, we hypothesise that:

H_4: Transportation of PMS via trucks in Nigeria significantly causes scarcity of the product in the FCT and environs.

3. Methodology

The study was carried out in Abuja and environs. Abuja is the federal capital territory (FCT) and the administrative capital of Nigeria. It has a population of 778, 567 people in 2006 (National Population Commission, NPC, 2006). It is bounded by Kaduna, Kogi, Niger and Nasarawa States. Initially, data for the study was supposed to be collected from the petrol stations in the FCT but getting to Abuja, we discovered that because of the strict implementation of the territory urban planning law, there are fewer filling stations in the capital city than in the satellite/border towns. These towns are densely populated by people working in the capital city due to the high costs of accommodation in the city. These border towns include Gwagbwalada and Nyanya, outskirts of Abuja, Keffi in Niger State and Maraba in Nasarawa State. Because of the high density of population in these towns, many businesses including filling stations are established to cater for the needs of the people. Therefore, data were collected from the filling stations in the FCT, Gwagbwalada, Nyanya, Maraba and Keffi.

The study adopted a cross-sectional survey research design, with the data obtained in FCT and environs between February 10 and 19, 2014. The population consisted of all the petrol retail outlets (including the NNPC, the major and the independent marketers' outlets) in the study area. The sample size of 300 respondents was selected and the sampling unit was managers and supervisors of the filling stations. Data were obtained through a structured questionnaire, which had 2 sections. A Likert scale question type was used on a scale of 5, with 5 point allocated to strongly agree and 1 point to strongly disagree. The development of the questions in the questionnaire was guided by the review of the literature (Aminu, 2013b) and was adjusted to conform to the research questions.

The questionnaire was subjected to a content validity to ensure that all the items in the questionnaire are good measures of the study's constructs. A content validity is established by ascertaining that the items in the instrument measure all the dimensions of a given construct (Carmines & Zeller, 1991). Our colleagues in the institution and dealers of petroleum products in Oshodi-Isolo Local Government Area Council were given the questionnaire to validate. Adjustments to the questionnaire were made to reflect their observations and comments. In addition to the content validity, factor analysis was also carried out on a purposive sample of 47 respondents between February 3 and 4, 2014 at selected filling stations in Oshodi-Isolo Area Council. This enabled us to pretest the questionnaire and to ascertain the degree to which the instrument can be used in future under different conditions (reliability) and to undertake construct validity and purify the scales. An exploratory factor analysis was undertaken on the original 29 items in the pre-tested questionnaire through principal component method of extraction with a varimax rotation. The outcome was reduction from 29 to 25 items.

The Cronbach's Alpha was used to measure the internal consistency of the research questionnaire. Cronbach's alpha reliability coefficient normally ranges between 0 and 1 with higher values indicating higher reliability among the indicators (Cronbach, 1951). This means that the closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale (Aminu, 2013b). This is depicted in table 5 below. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) was used to determine the adequacy of the pilot study's sample size. This is shown in table 6 below. The hypotheses were tested using Pearson Product Moment Correlations. The main data was subjected to analysis to enable us draw logical conclusions. The analysis includes descriptive and inferential statistics facilitated by Statistical Package for Social Sciences (SPSS), version 17.0. Descriptive statistics was presented in table 8 while inferential statistics was presented in tables 9 to 12.

4. Results and discussion

4.1 Results

Table 5: Reliability of the Research Instrument

Constructs	Number of Items	Cronbach's Alpha
Scarcity of PMS in Lagos State, Abuja (SOPMS)	4	.784
Low refining output of Nation's Refineries (LRO)	6	.803
Inadequate pipeline network (IPN)	7	.841
Perennial pipeline vandalism and rupture (PVR)	6	.827
Transportation of PMS through oil tankers (TPMS)	7	.863
Overall coefficient Alpha	29	.898

Source: Pilot Study, 2014

The table shows Cronbach's Alpha for all the five constructs measuring the internal consistency of the scale. The overall coefficient Alpha for the scale was 0.898, which is greater than an acceptable threshold (Cronbach, 1951; Nunally, 1978) while coefficient alpha for each of the subscales are as follows: SOPMS (0.784), LRO (0.803), IPN (0.841), PVR (0.827) and TPMS (0.863). These Alphas indicate that our instrument is reliable and can be used by future researchers.

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Table 6: KMO and Bartlett's Test

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.785
Bartlett's Test of Sphericity	Approx. Chi-Square	202.434
	Df	42
	Sig.	.000

Source: SPSS output, 2014

The KMO of .785 is very large and above the .60 threshold, suggesting that a sample size of 47 for the pilot study was large enough and appropriate for factor analysis. Similarly, Bartlett's test of sphericity was 202.434 and significant at p<.000. This is significant, thus making us reject the hypothesis that the intercorrelation matrix between our five variables is an identity matrix. In line with Bagozzi and Youjae (1988), items that correlated negatively with one another or did not correlate strongly with the sum of the remaining items were removed. In all four items were removed.

Table 7: Factor Loading with Varimax Rotation

Items	Low refining output (LRO)	Inadequate pipeline network (IPN)	Pipeline vandalism & rupture (PVR)	Transportation of PMS (TPMS)	Variance explained
Items	1	2	3	4	
LRO 1	0.716				
LRO 2	0.549				
LRO 3	0.585				
LRO 4	0.831				12.345
IPN 1		0.594			
IPN 2		0.717			
IPN 3		0.584			
IPN 4		0.623			14. 641
PVR 1			0.765		
PVR 2			0.575		
PVR 3			0.746		
PVR 4			0.502		
PVR 5			0.523		16.041
TPMS 1				0.664	
TPMS 2				0.505	
TPMS 3				0.615	
TPMS 4				0.576	
TPMS 5				0.672	
TPMS 6				0.538	
TPMS 7				0.629	20.842
Total variance					63.869

Table 7 shows exploratory factor analysis (EFA) based on principal component analysis as the extraction method using Varimax rotation with Kaiser Normalisation. EFA allowed us to group variables together into four factors. For the purpose of purification, all items that did not load significantly on the primary factor (0.5) were removed from the scale, thus reducing the original scale to 25 items. The factor loadings for each of the variables in the scale are shown in the table. Four factors (low refining output, inadequate pipeline network, pipelines vandalism and rupture and transportation of PMS by trucks) were extracted because the variables loaded most strongly on. 63.87 per cent of the variability in the dataset is accounted for by these factors.

Table 8: Descriptive statistics

Variables	Frequency	Percentage	Variables	Frequency	Percentage
Age:			**Company:**		
21-30 years	55	32.2%	Major Petrol Stations	72	42.1%
31-40 years	91	53.2%	Independent Stations	78	45.6%
41-50 years	22	12.9%	NNPC Stations	16	9.4%
Above 50 years	03	1.8%	PPMC	05	2.9%
Total	171	100.0%	**Total**	171	100.0%
Sex:			**Designation:**		
Male	122	71.3%	Officers	08	4.7%
Female	49	28.7%	Supervisors	88	51.5%
Total	171	100.0%	Managers	75	43.9%
			Total	171	100.0%
Qualification:			**No. of years in the company:**		
O' Level	22	12.9%			
ND	98	57.3%	1-5 years	61	35.7%
HND/B.Sc./BA	45	26.3%	6-10 years	88	51.5%
Post-graduate/Professional	06	3.5%	Above 10 years	23	12.8%
Total	171	100.0%	**Total**	171	100.0%

Source: Field Research, 2014.

From table 8 above, 55 respondents (32.2%) fall in the age category of 21-30 years; 91 respondents (53.2%) are between the age of 31 and 40 years; 22 respondents (12.9%) are between 41 and 50 years, while just three respondents, representing 1.8% are above 50 years. Majority of the respondents are between 31 and 40 years, suggesting that majority of the respondents are matured enough for this study. In terms of sex, 122 of the respondents (71.3%) are male; while 49 (28.7) are female. Majority of the respondents are male, which may be explained within the cultural context of the north where there are more male workforce than their female counterparts. With respect to academic qualification, 22 respondents (12.9%) have ''O'' Level certificate; 98 respondents (57.3) have ND certificate; 45 respondents (26.3) have B.Sc. degree or its equivalent; and six respondents (3.5%) have post-graduate/ professional qualifications. Majority of the respondents have ND qualification, indicating that manamagement of petrol stations does not require higher education.

Furthermore, 72 respondents (42.1%) work in major filling stations; 78 respondents (45.6%) are employees of independent filling stations; 16 respondents (9.4%) work with NNPC filling stations; the remaining five respondents (2.9%) are employees of PPMC. Therefore, majority of the respondents are employees of independent filling stations, majority of which are located in the outskirts of Abuja and in the border towns. Designation distribution of the respondents shows that eight respondents (4.7%) are officers; 88 (51.5) are supervisors; while 75 (43.9) are managers. This analysis indicates that majority of the respondents are supervisors. Finally, 61 respondents (35.7%) have worked in their companies for a period of 1 to 5 years; 88 respondents (51.5%) have been with their organisations between 6 and 10 years; 23 respondents (12.8%) have worked for above 10 years. Therefore, majority of the respondents have between 6 and 10 years experience, suggesting that they have work long enough to understand the challenges of petroleum products distribution.

Table 9: Relationship between low refining output and scarcity of PMS in FCT, Abuja and environs.

Variables	No. of cases	Mean	Standard Deviation	Coefficient of Correlation	P-Value
Low refining output	171	15.85	3.697	.387**	.000
PMS scarcity in FCT and environs		19.21	4.335		

****correlation is significant at the 0.05 level (2-tailed).**

Table 9 shows the correlation between low refining output and scarcity of PMS. The correlation coefficient (r) of low refining output to scarcity of PMS in FCT and environs is .387 and the significance level is 0.05 (pÂ.01). The table shows that the p-value is 0.000, which is less than 0.05. We therefore accept the alternative hypothesis and conclude that low refining output has a significant impact on scarcity of PMS in FCT and environs ($r = .387$, $p < .005$). The coefficient of determination (r^2) is .1497, which indicates that about 15 per cent of the variance in PMS scarcity in the study area can be explained by low refining output of the nation's four refineries, while the remaining variance (about 85 per cent) cannot be explained by this construct, but may be accounted for by other factors.

Table 10: Relationship between inadequate pipeline and scarcity of PMS in FCT, Abuja and environs.

Variables	No. of cases	Mean	Std Dev.	Coefficient of Correlation	P-Value
Inadequate pipeline infrastructure	171	13.70	4.140	.445**	.000
PMS scarcity in FCT		19.21	4.335		

****correlation is significant at the 0.05 level (2-tailed).**

Table 10 shows the correlation between inadequate pipeline network and scarcity of PMS. The correlation coefficient (r) of inadequate pipeline network to scarcity of PMS in FCT and environs is .445 and the significance level is 0.05 (pÂ.01). The table shows that the p-value is 0.000, which is less than 0.05. We therefore accept the alternative hypothesis and conclude that inadequate pipeline network significantly causes scarcity of PMS in FCT and environs ($r = .445$, $p < .005$). The coefficient of determination (r^2) is .1980, which indicates that about 20 per cent of the variance in PMS scarcity in the study area can be explained by inadequate pipeline infrastructure in Nigeria, while the remaining variance (about 80 per cent) cannot be explained by this construct.

Table 11: Relationship between pipeline vandalism and scarcity of PMS in FCT, Abuja and environs.

Variables	No. of cases	Mean	Std Dev.	Coefficient of Correlation	P-Value
Inadequate pipeline infrastructure	171	17.66	3.990	.301**	.000
PMS scarcity in FCT		19.21	4.335		

****correlation is significant at the 0.05 level (2-tailed).**

Table 11 shows the correlation between pipeline vandalism and scarcity of PMS. The correlation coefficient (r) of pipeline vandalism to scarcity of PMS in FCT and environs is .301 and the significance level is 0.05 (pÂ.01). The table shows that the p-value is 0.000, which is less than 0.05. We therefore accept the alternative hypothesis and conclude that pipeline vandalism has a significant effect on scarcity of PMS in FCT and environs ($r = .301$, $p < .005$). The coefficient of determination (r^2) is .0906, which indicates that 9 per cent of the variance in PMS scarcity in the study area can be explained by frequent pipeline vandalism, while the remaining variance (about 91 per cent) cannot be explained by this construct, but may be accounted for by other factors.

Table 12: Relationship between bridging and scarcity of PMS in FCT, Abuja and environs.

Variables	No. of cases	Mean	Std Dev.	Coefficient of Correlation	P-Value
Bridging (truck haulage)	171	25.59	5.438	.352**	.000
PMS scarcity in FCT		19.21	4.335		

****correlation is significant at the 0.05 level (2-tailed).**

Table 12 shows the correlation between transportation of oil through tankers (otherwise known as bridging) and scarcity of PMS. The correlation coefficient (r) of bridging to scarcity of PMS in FCT and environs is .352 and the significance level is 0.05 (pÂ.01). The table shows that the p-value is 0.000, which is less than 0.05. We therefore accept the alternative hypothesis and conclude that bridging has a significant impact on scarcity of PMS in FCT and environs ($r = .352$, $p < .005$). The coefficient of determination (r^2) is .1239, which indicates that about 12 per cent of the variance in PMS scarcity in the study area can be explained by the challenges associated with bridging, while the remaining variance (about 88 per cent) cannot be explained by this construct.

4.2 Discussion

This paper has empirically investigated the challenges of PMS distribution in FCT and environs and come up with a number of instructive findings. Regrettably, empirical studies on the relationship between all the independent variables and the dependent variable of the paper are scarce in the extant literature, suggesting an important gap filled by this paper; therefore, discussion of the findings is based largely on conceptual review.

The first finding shows that low refining output of the nation's refineries have a significant impact on scarcity of PMS in FCT and environs. This result is not unexpected as the nation's four refineries are operating at a level considerably below their installed capacity. The combined installed capacity of all refineries is 445,000 bpd but evidence from the OPEC statistics shows that the refineries were operating at 18.5% of the capacity, yielding a paltry 82,400 bpd as at December, 2012 (OPEC, 2013). The output dipped to 10.5% in June, 2014 (NNPC, 2014 as cited in Punch, 2014). In terms of litres of PMS produced per day, Eboh and Ejoh (2014) cited Momoh (2014) as disclosing that the refineries are currently yielding about 5.10 million litres of PMS daily compared to an average of 40 million litres required daily. Siebert and Rauscher (1985) had predicted that unless Nigeria increases its refining capacity it may have challenges satisfying domestic requirements for finished products from their refineries. Today, Nigeria is exactly in this sorry and shameful state as it is unable to refine sufficient PMS and other petroleum products for local consumption. This is in spite of having added capacity through the construction of the Port Harcourt II Refinery in 1989 with 100,000 installed capacity.

Adenikinju and Falobi (2006) analysed the published data by NNPC on refinery capacity and output between 1981 and 2001 and concluded that, for most part of the period covered, the refinery output fell short of the installed capacity, thus leading to the shortfall met with importation. The length of time it takes to order and ship petroleum products to the country causes lag in the product delivery. Also, delay by the government to pay subsidy claims by marketers may also cause delay in the process of importing petroleum products from abroad (future research should investigate this). In Kuwait, Iraq's invasion of Kuwait, leading to

1990 gulf war, devastated most of the Kuwait's refineries and led to shortage of petroleum products, resulting in higher prices (Chakravorty et al., 2000; Weinhagen, 2003).

The second finding indicates that inadequate pipeline network in Nigeria has a significant impact on scarcity of PMS in FCT and environs. This result is not unexpected as pipelines remain the most reliable, safest and cost effective means of distributing petroleum products (Indicus Analytics, 2009; Moses, 2012) because they can move large volume of refined products (Bjornmose et al., 2009), thereby guaranteeing smooth and regular flow of the products. Unfortunately, the pipeline density of an estimated distance of 5,001 km in the country (Adenikinju & Falobi, 2006; Onuoha, 2012) is grossly inadequate to serve the Nigerian massive land mass and population. This contrasts over 500,000 miles (804,500 km) of pipeline network in the U.S. (Furchtgott-Roth, 2013), 415,152 km in Alberta Province in Canada (AER, 2013) and 51,496 km in India (Petrotech, 2012). Within OPEC, Saudi Arabia with a population of less than 30 million has a pipeline network length of over 9,000 miles (over 14,481 km, EIA, 2013). While sufficient pipeline network in these countries guarantee regular supply of fuel, the limited pipeline network in Nigeria is not sufficient to guarantee efficient and smooth supply of PMS in the country, thus making the country rely on bridging (transportation of fuel through tankers).

Next, the finding reveals that pipeline vandalism and rupture has a significant impact on scarcity of PMS in FCT and environs. Expectedly, the twin problems of vandalism and rupture are a major constraint against the smooth distribution and supply of PMS in FCT and environs. The limited pipelines have been a target of incessant attacks by vandals, thieves and criminals. In particular, the increasing wave of attack on System 2B pipeline that supplies about 11 millions litres of petrol to the south-west and the north often have adverse effect on the supply of PMS in FCT and environs. Indeed, the FGN recently decried the high incidence of pipeline in the country, disclosing that 80 per cent of the country's pipeline network for petroleum product distribution have been sabotaged (Eboh & Ejoh, 2014). While factors such as unemployment, poverty and hunger have been adduced as factors fueling pipeline vandalism in Nigeria (Ashby et al., 2006; Oluwatuyi & Ileri, 2013; Oteh &

Eze, 2011; Vidal, 2011), Anifowoshe et al. (2011) found a negative correlation between interdiction (pipeline vandalism) and poverty in the country.

NNPC (2012) identified vandalisation of oil pipeline infrastructure as a critical challenge facing the industry. It reported that 16,685 (19,5%) of the 16,083 pipeline breaks that took place between 2003 and 2012, was as a result of the activities of the vandals resulting in product loss, financial loss, environmental degradation, health hazards and loss of life. Table 3 above shows that total product loss within the 11-year period was to 3,035,897 metric tons, which translates to 4,071,138, 454 litres (where one metric ton is equal to 1,341 litres). According to NNPC (2010) the lost volume is almost the total volume, 4.6 billion liters consumed in the entire 1995 and more than one-quarter of 17.1 billion liters consumed in 2010. Inevitably, this huge product loss is substantial enough to cause shortage of the product as frequently experienced in the FCT and other parts of the country.

Similarly, lack of regular maintenance of pipeline infrastructure in Nigeria also causes rupture and leakages of petroleum products with its negative effect on the supply of PMS in the FCT and environs. For instance, Onuoha (2008) identified the trio of oil bunkering, pipeline vandalism and oil terrorism as the main dimensions of oil pipeline sabotage in the country and warned that unless the government makes concerted efforts to curb the rising scourge, its capacity to guarantee energy security would be compromised. Unlike in other climes, the pipelines in the country are not regularly monitored and checked for corrosion to detect weak pipelines and prevent rupture. In Alberta, Canada, pipelines that are prone to greater risks are more strictly inspected by Alberta Energy Regulator (AER, 2013). The incidence of pipeline rupture, though small in relation to pipeline vandalism, also causes product loss resulting in product scarcity. Pipeline ruptures are caused by aged pipes, mechanical faults, corrosion, inadequate monitoring, natural disasters, poor maintenance and accident (Achebe et al., 2012; Anifowoshe et al., 2011; Vidal, 2011). Unfortunately, Vidal decried the age of many pipelines, which he put at 40 years old, causing heavy corrosion and leakage of gas and oil. Eboh and Ejor (2014) cited Momoh (2014) as admitting that the country is having the challenge of distributing products through the network of pipelines available in the country due to the twin problems of pipeline vandalism and rupture stemming from the aging of the pipelines.

Finally, the finding of this research shows that transportation of PMS via petrol tankers in Nigeria significantly causes scarcity of the product in the FCT and environs. This result is instructive as there is heavy reliance on transportation of PMS and other petroleum products across the length and breadth of the country. This heavy reliance is affirmed by Akpoghomeh and Badejo (2006) who explained that bridging accounts for between 78 and 82 per cent of domestic consumption in terms of volume in contrast to less than four per cent used in the U.S. (Freese, 2007). Inadequate pipeline infrastructure and frequent vandalism of the limited pipelines have led to the shift in the emphasis from distribution through pipeline to distribution through roads (Adenikinju & Falobi, 2006; Akpoghomeh & Badejo, 2006; Akpoghomeh & Odili, 2000; Ehikwe & Ngwoke, 2013).

Fuel haulage in Nigeria is plagued by a long haulage covering several kilometres (National Mirror, 2012) in contrary to the best practice of a short haulage of an average of 100 kilometres (Akpoghomeh & Badejo, 2007; Freese, 2007), thus causing delay in the delivery of PMS to stations in the north (Obasanjo et al., 2014) including FCT and environs. Besides, studies have suggested that poor road conditions, frequent truck breakages on the road and spillage of petrol may constitute a major threat to the regular and timely supply of PMS to retail outlets in FCT and environs (Adenikinju & Falobi, 2006; Ehinomen & Adeleke, 2012). The limited number of trucks and their low capacity (33,000 litres) as a mode of transportation, combined with the longer haulage distance it will take to move the product, on bad road network, from the south to the north may cause fuel crisis in the FCT and environs. For example, Eboh and Ejoh (2014) cited Momoh (2014) as lamenting the limited number of oil tankers for product haulage and the bad state of the Nigerian roads. Obasanjo et al. (2014) found that bad road in Nigeria is one of the three leading constraints to haulage of petrol in the northern region of the country. The bad roads often cause accident for petrol tankers resulting in product loss, human loss and truck wreckage. In this regard, it is noted that the current rate of petroleum tanker accidents in the country have sent shivers down the spine of most Nigerians (Shosanya, 2012) and that moving bulky and heavy products like fuel and cement on poorly maintained roads have turned the highways into horrifying death traps, with attendant heavy toll on life and property (National Mirror, 2012).

5. Conclusion and policy implications

Nigerian downstream petroleum, in spite of the country's membership of the OPEC, has been plagued by multitude of problems resulting in irregular distribution and scarcity of PMS and other petroleum products in FCT, Abuja and the entire country. The paper has empirically investigated the roles four of these challenges has played in contributing to the scarcity of petrol sometimes experienced in the FCT and environs. All the research constructs (low refining output, inadequate pipeline infrastructure, pipeline vandalism and rupture and bridging of petrol through road transportation) are found to significantly affect PMS supply and cause scarcity of the product in the FCT and environs. Inadequate pipeline infrastructure has the most significant impact on PMS supply in the area. Based on these findings, we conclude that: the low refining capacity of the nation's four refineries, causing importation of over 80 per cent of the domestic requirement is a challenge militating against smooth supply of PMS in the FCT and environs; 5,001 km of pipelines is grossly inadequate to distribute PMS across the length and breadth of the country, and this causes shortage of PMS in the FCT and environs; the vandalism of the limited pipeline infrastructure, resulting in product loss, has frequently disrupted effective PMS distribution from the south-west to the FCT and environs; and finally, the haulage of PMS through several kilometres of bad roads also disrupts supply of PMS to the FCT and environs through delay in product delivery, loss of product to accident and diversion of products.

The findings of this paper have a number of implications for policy-makers in Nigeria. The low refining capacity of the government-owned refineries, despite billions of dollars spent on turn-around maintenance (TAM), implies that the government is incompetent to manage the critical infrastructure like refineries, contrary to the situation in many OPEC members such as Saudi Arabia, Iraq, Iran and Venezuela, where refineries are operating at high capacity. Punch (2012) lamented that billions of dollars spend on TAM over the years have disappeared into thin air. Therefore, policy-makers should consider privatising these refineries to core investors and not politicians and cronies of the presidency who have no technical expertise to manage complex installations like refineries. The privatisation should not go the way of the Power Holding Company of Nigeria (PHCN), which was handed-over to investors in November, 2013 who do not have requisite financial and technical capability.

Aliko Dangote's pioneering initiative to build 500,000 bpd refining, petrol chemical and fertilizer complex in the country is commendable. The policy-makers should provide incentives to the 18 private investors who were licensed by the Obasanjo's administration to encourage them build more refineries in the country and make Nigeria the hub for petroleum products refining and exporting in Africa. Singapore and India import crude oil but produce large quantity of PMS from their local refineries for the entire Asian region.

The inadequacy of the pipeline networks necessary to achieve efficient and effective distribution of PMS implies that there is a need for massive investment in pipeline infrastructure through public-private partnership. Nigeria is a big country and requires extensive pipeline network to achieve efficient and effective PMS distribution. Not until when huge investment is attracted, pipeline network of 5,001 kilometres are too limited to guarantee regular availability of PMS and other petroleum products in the nook and cranny of the country. To attract the needed investment there is also a need for quick passage of Petroleum Industry Bill (PIB) by the National Assembly and assent by the President to provide necessary legal framework for investment drive in the downstream sector.

Furthermore, the rising incidence of pipeline infrastructure in the country implies that the governments and its security agencies are not doing enough to secure the pipelines and therefore, will need to do more to secure these installations. Policy-makers should consider employing technology to address this heinous act of vandalism. One way of achieving this is through the use of the Horizontal Directional Drilling (HDD) technology, which allows oil pipelines to be laid without drilling trenches and make it easier for pipelines to be monitored and surveyed. Additionally, modern camera technology can be installed for pipeline surveillance. Unfortunately, policy-makers are paying lip service to the adoption of this technology despite the deterioration in pipeline vandalism. For example, FGN is yet to decide on the adoption of this technology as Momoh (2014) revealed that the FGN is considering the use of HDD and surveillance technology to address the problem of vandalism. The expectation of several Nigerians is that, with the magnitude and ferocity of pipeline vandalism in the country, government should have acted rapidly rather than 'considering'.

In addition, the rising incidence of pipeline vandalism is a clear indication of the pervasiveness of poverty in the land. For example, it was concluded "that the decisions by successive governments to frequently hike petrol price have expanded the poverty gap in the country" (Aminu, 2013c:21). Therefore, the policy-makers should formulate growth-inclusive policies that would reduce the 'masses of poor' and stop flaunting controversial growth figures that have excluded the masses. Finally, the incidence of ruptured pipelines implies that policy-makers should mandate NNPC and multinational oil companies to regularly maintain existing pipelines and replace aged pipelines with new, modern ones.

The implication of the increasing reliance on trucks to transport PMS and other petroleum products, over a long distance and on bad roads, from the south to the FCT and other states in the north is delay in delivery of products and sometimes loss and/or diversion of products. Therefore, measures should be taken by the policy-makers to de-emphasise long haulage of petroleum products as this is inappropriate. Use of truck to transport petroleum products is usually for short distance of about 100 kilometres. Prior to the time this would be achieved efforts should be made by the government to rehabilitate bad roads, expand the existing ones and build new ones to smoothen the movement of products by roads. Similarly, incentives should also be provided by government to ease acquisition of new trucks that would support the current fleet of about 500 trucks moving products from Lagos to the north and accelerate the movement of products from Lagos to the FCT other states in the country.

The findings of this paper are limited by its scope, the FCT and environs and by the small size of the sample, both of which may affect the generalisation of the findings to the entire country. As a result, there is need for further studies to cover many states and use a larger sample size. Also, additional studies should investigate the impact of other challenges (truck diversion, smuggling of fuel to the neighbouring countries and fuel import) on scarcity of PMS in the country. Finally, there is a need for studies on the implications of privatisation of the refineries and pipelines for PMS supply and availability in the country.

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