

PERCEIVED ENVIRONMENTAL IMPACT OF REFINED PETROLEUM PRODUCTS TRANSPORTATION AND DISTRIBUTION: CASE OF KADUNA CITY, NIGERIA

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Abstract

Transportation and distribution of petroleum products in Nigeria have been associated with a lot of environmental hazards which have resulted to social and economic losses. This paper therefore attempts to examine the distribution system and assess the perceived environmental impacts associated with fuel transportation and distribution in Nigeria by different modes of transportation. Using a questionnaire survey, the results of an analysis of people's perceptions of identifiable environmental impacts show traffic accident and fire outbreak rated highest, and contributing 28.58% and 28.29% of the perceived impacts. Of the impacts of different modes of transportation, pipeline transport was perceived as having worst records of environmental impact contributing 31.03%, followed by road haulage contributing 29.36%. In addition, the comparative analysis of the impact among different modes using Chi-square method also indicate that there is high level of agreement among the respondents on their perceptions of environmental impacts generated by different modes of transportation. The paper finally suggested that modes with least perceived environmental impacts should be used mainly for fuel transportation and distribution. The need for complete deregulation of the downstream sector of the oil industry is also advocated as a solution to the problems of transporting and distributing petroleum products in Nigeria.

Key words: transportation, distribution, refined, petroleum, products, impacts, environment

1. Introduction

Fuels, particularly refined petroleum products, which include premium motor spirit (PMS or Petrol), household kerosene (HHK) or dual purpose kerosene (DPK), automotive gas oil (AGO or diesel) and aviation turbine kerosene (ATK or Jet-AI) are major petroleum products that drive Nigeria's economy. The economy of Nigeria is monolithic in nature, dominated mainly by the oil sector (Arinze, 2011; Adelaja, 2006). The oil sector alone contributes 95% to the country's export earnings (Odularu, 2008). The recent rebasing of the Nigeria's GDP shows some appreciable level of economic diversification, yet the oil sector still plays a major role. The current GDP of the country shows that the oil sector contributes 10.45% of the country's total GDP (NBS, 2014). Due to the dominant role of the oil sector in the overall development of Nigeria's economy, any policy decision on this important sector often affects almost every other sector of the economy.

Over the years, the issues of appropriate pricing of petroleum products for the domestic market and making petroleum products available to consumers across the country have been burning issues that often result to political and social unrests in the country (Ehikwe & Ngwoke, 2013). One underlying factor responsible for determining appropriate pricing and availability of the petroleum products is how effective and efficient are the transportation

and distribution systems of these products from the producers to the end users (Ehikwe and Ngwoke, 2013).

However, the transportation and distribution costs of refined petroleum products are not limited to the monetary aspect; there are other external costs which are borne by the society (Eke & Enibe 2007). These costs include environmental impacts generated by different modes being used for transporting and distributing petroleum products across the country (Rodrigrue, 2017). These impacts include accidents, oil spillage, noise pollution and fire outbreak. In transport cost accounting, these are often neglected, because they are not very apparent or perceived by the users of the transportation. Apart from the environmental impacts, transportation and distribution of petroleum products are also associated with the problems of delays, diversion, high cost of loading and transportation. This paper therefore tries to assess fuel transportation and distribution problems in Nigeria and its perceived environmental impacts with the aim of providing solutions that will eliminate or at best reduce to the barest minimum the perceived environmental impacts associated with it.

2. Methodology

To gather empirical data on environmental and socio-economic impact of fuel transportation and distribution, a survey of how people perceive the environmental impact of different modes of transport was carried out in Kaduna using a random sampling method targeting people living along rail, road, and pipeline corridors. Those who live along the bank of River Kaduna were also covered to find out their perceived impact of water transportation. Water transportation in the city is limited to movement of local farmers and fishermen and transportation of local agricultural produce within the locality. Fuel transportation is precluded because the river is not wide enough for navigation. A checklist of different aspects of environmental impact was given to them and they were asked to assess them based on their individual perceptions.

The study area is Kaduna metropolis which mainly comprises of Kaduna North and Kaduna South Local Government Areas (LGAs). The total population of the two LGAs as at 2011 was estimated to 891,490 people. It was presumed that the population of people living around the major corridor of the four modes of transport identified should not more than 10% of the total population of Kaduna city. The 10% translates to a population of 89,149. For the purpose of the study, two major roads within Kaduna metropolis were purposively sampled. The traffic corridors are Ahmadu Bello Way and Eastern Bye-Pass. In addition, the Sabo – Kawo rail line, NNPC Pipeline and the major banks of Kaduna River were surveyed. The residents of the selected traffic corridors were sampled using simple random sampling technique to get 360 respondents out of a population of 89,149. Questionnaires were administered to these respondents such that 120 respondents were sampled on each of the three traffic modal corridors to make a total of 360 respondents to form the sample size for the study. 345 copies of the questionnaires were returned completed representing a 95.8% success rate.

The questionnaire contains two sets of table of four identified environmental impacts for different modes of transportation used in the movement and distribution of petroleum products. The respondents were asked to rank and score the different environmental impacts, with 1 representing Very Low, 2 for Low, 3 for Moderate, 4 for High and 5 for Very High. The scores assigned by the respondents were used to measure their perceived impacts quantitatively. Oral interviews were conducted with some of the representatives of major

and minor marketers of petroleum products in the city to elicit information on their perceptions of the environmental impacts of different modes of transport used in transporting their fuels to their retail outlets. The total average ratings of the respondents were computed. Data collected were analysed using chi-square, while results were presented in Tables. The secondary data used in this paper were collected through review of NNPC's relevant reports and other previous related studies and works done in this area.



Figure 1 shows the map of the study area.

3. Results and Discussion

3.1 Transportation of Refined Petroleum Products

Due to the acute shortage of refined petroleum products experienced especially in the late 90s and early 2000, the government resorted to importation of refined petroleum products to supplement the local production by the nation's refineries. Table 1 shows the breakdown of major and minor marketers in six geo-political zones in Nigeria. From the table, the South-West including the Lagos axis has the largest number of major and minor marketers in the country, followed by South-South geo-political zone. The zone with the fewest marketers is the North-East. These marketers transport refined petroleum products either from the refineries and NNPC depots or, in the case of imported products, from the ports.

Table 1: Distribution of Petroleum Product Marketers across Six Geo-Political Zones in Nigeria in 2014

Geo - Political Zone	Marketer type Major	Market Type Minor	Total Number of Outlets		
North-Central	355	1318	1673		
North-East	163	726	889		
North-West	265	1023	1288		
South-East			194	1227	1421
South-South			224	1519	1743
South-West			1017	2135	3152
TOTAL			2218	7948	10166

Source: PPPRA (2014) www.pppra-nigeria.org

The major duty of the licensed oil marketers is to import, supply and market refined petroleum products across the country to guarantee the continuous supply of products. The challenge the country is facing up till now is the high social, economic and environmental cost of transportation and distribution of these products while ensuring the continuous supply of refined petroleum products across the country. Pipeline and road haulage are the major modes of transporting refined petroleum products in Nigeria. Globally, pipeline is the most economic and effective mode of transporting liquid and gaseous materials over a long distances. That is why a network of pipeline was initially laid across the Nigeria's landscape to provide channel of transporting the refined petroleum products from the refineries to the major centres of consumption. Figure 2 shows the network of pipelines for the transportation of petroleum products across locations in Nigeria, a network estimated to be over 5,120km of pipelines crisscrossing the country. Unfortunately, about 80% of it has been destroyed through vandalism (Vanguard October 30, 2014).

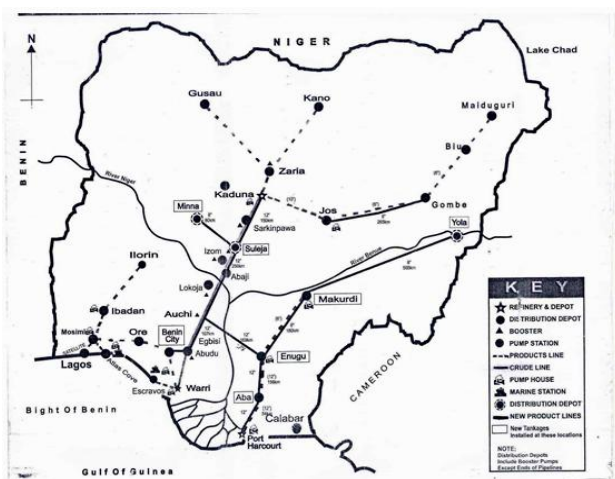


Figure 2: Pipeline Network in Nigeria for Fuel Transportation

2.2 Problems Associated with Pipeline Transportation

In spite of a widespread network of pipelines laid across the country to facilitate the transportation of refined petroleum products, over 90% of refined petroleum products are

still transported by road. The major problems associated with pipeline transportation mode include:

- Deliberate acts of vandalism. It was recorded that between 2002 and 2011 there were 18,667 of cases of pipeline vandalism the country. From data released by Pipelines and Product Marketing Company, a subsidiary of the Nigerian National Petroleum Corporation, the highest number of recorded cases 5,518 instances of vandalism occurred in 2010. This is followed by 2011, 2012 and 2013 with 4,468, 3,708 and 3,571 cases respectively.
- Oil theft along pipeline. Due to the activities of vandals, the country has lost 712, 776 cubic meters, of PMS (petrol) in the last four years. (Ragbroko, 2013).
- Oil spillage especially when there is leakage of pipeline.
- Rigid channel of transportation.

The above problems perhaps are some of the reasons for the dominance of road haulage in the transportation of refined petroleum products in Nigeria.

3.3 Road Transportation of Refined Petroleum Products

As a matter of fact, transportation by road is the dominant transportation mode in Nigeria, with about 90% of goods and people being transported by road (Ojekunle, 2006). Apart from apparent neglect and under development of other modes of transportation by the government for moving petroleum products, other reasons for this dominance can be attributed to the door to door service it offers, the flexible nature of road mode and its simplicity in operation.

In spite of these inherent advantages, transporting refined petroleum products over long distances above 300km does not make economic sense. For instance, Nnaji (1997) discovered that it is ten times cheaper to transport refined petroleum products through pipelines than by road. Apart from the economic benefits of moving refined petroleum products by pipeline, there are socio-economic and environmental benefits. Pipeline transportation is more environmental friendly because it produces less noise, less air pollution and accidents can be minimized. A lot of problems are associated with the use of road as a mode of transporting refined petroleum products; these include

- i. Increased rate of road accidents. Tanker and trucks contribute significantly to the road accidents on Nigerian highways. Table 2 shows the records of road accidents in Nigeria, indicating that about 10% of road traffic accidents on Nigerian roads between 2007 and June 2010 involved tanker trucks.

Table 2: Road Traffic Accidents Involving Tanker/Trailers

YEAR	Total No of Road Traffic Accidents	No of Accidents Involving Tankers	% of the accidents involving trailers	No of Tanker Vehicles involved	No of injured	No of Persons Killed
2007	8,477	607	7.16	976	2169	805
2008	11,341	1229	10.84	1655	3891	1221
2009	10,854	1213	11.18	1767	3714	1085
2010 (Jan- Jun)	5,330	968		1427	3220	965
Total		4017		5825	12994	4076

Source: FRSC Report 2010

In addition, an average of over 1000 people died through tanker/ trailer vehicle yearly. This is very alarming!

- ii. **Diversion of petroleum products.** There is high rate of diversion of petroleum products to illegal destinations. These illegal practices are very common among the tanker drivers especially whenever there is scarcity.
- iii. **Fuel pilfering.** This is also a common activity that happens in transit by road transportation. Some tanker drivers illegally siphon fuels and sell them in the black markets before getting to the final destinations. These black markets are found along intercity highways and at major rest station towns and villages. They do these unwholesome practices at the expense of the marketers who own the fuels.

2.3 Assessing the Impacts of Fuel Transportation

An attempt is made here to assess the identifiable environmental impacts of fuel transportation in Nigeria as perceived by the people living along the transport corridors. The analysis of the questionnaire survey carried out shows how people rated the impacts of different modes of transport used for fuel transportation in Nigeria.

Table 3 indicates that pipeline transport was rated highest as having the worst records of environmental impacts among all four modes. It had a total score of 3804, followed by road haulage with a total score of 3600 representing 31.03% and 29.36% respectively. The mode with least perceived environmental impact was rail transport with a total score of 1862 or 15.19%. In terms of different perceived environmental impacts, traffic accident was considered the worst, recording a total score of 3504 representing 28.58%. This was closely followed by fire outbreak with a total score of 3468 constituting 28%. The least perceived impact was noise pollution with total score of 1940 representing 15.82%. Despite the fact that road transport generates second highest externalities, the same mode still dominates the transportation system in the country. Rail and inland waterway modes of transport generated the least perceived environmental impact. Ironically, these two modes of transport are grossly underutilised in the country not only for transportation of fuels but also for the movement of other goods and people.

Table 3: Respondents' Rating of Environmental Impact of Fuel Transportation By Modes

Modes	Oil Spillage	Traffic Accident	Noise Pollution	Fire Outbreak	Total	%
Road	374	1261	654	1311	3600	29.36
Rail	443	647	345	427	1862	15.19
Pipeline	1478	625	390	1311	3804	31.03
Inland Water	1053	971	551	419	2994	24.42
Total	3348	3504	1940	3468	12260	100
%	27.31	28.58	15.82	28.29	100	

Source: Field Survey, 2014

Table 4 shows the statistical analysis of respondents' perceived environmental impacts of fuel transportation by different modes of transport. In order to perform the chi square test, the respondents' rating of environment impacts of different modes of transport were classified as either low or high. The perceived impacts were rated either as low or as high across different modes. The chi square test was carried out to determine whether the respondents' rating of different environment impacts across modes is significantly

differently. The chi-square result and the p-value (given a significant value of 0.005) are presented in Table 4.

Table 4 Perceived Environmental Impacts of Fuel's Transportation

Causes of Accidents	Respondents Rating	Response Proportion	Rate with the Highest freq.	Chi-square value	DF	P-value
ROAD						
Oil Spillage	Low	342	Low	329.186	1	0.000
	High	3				
Traffic Accident	Low	17	High	280.351	1	0.000
	High	328				
Noise Pollution	Low	292	Low	146.739	1	0.000
	High	53				
Fire Outbreak	Low	84	High	107.968	1	0.000
	High	261				
RAIL						
Oil Spillage	Low	267	Low	103.539	1	0.000
	High	78				
Traffic Accident	Low	72	High	117.104	1	0.000
	High	273				
Noise Pollution	Low	150	High	5.870	1	0.015
	High	195				
Fire Outbreak	Low	281	Low	136.490	1	0.000
	High	64				
PIPELINE						
Oil Spillage	Low	62	High	141.568	1	0.000
	High	283				
Traffic Accident	Low	120	High	31.957	1	0.000
	High	225				
Noise Pollution	Low	318	Low	245.452	1	0.000
	High	27				
Fire Outbreak	Low	62	High	141.568	1	0.000
	High	283				
INLAND WATERWAYS						
Oil Spillage	Low	114	High	39.678	1	0.000
	High	231				
Traffic Accident	Low	189	Low	3.157	1	0.076
	High	156				
Noise Pollution	Low	329	Low	283.968	1	0.000
	High	16				
Fire Outbreak	Low	283	Low	141.568	1	0.000
	High	62				

Source: Output from SPSS analysis (2016)

The result for road transport shows that traffic accidents and fire outbreaks are rated high. This implies that traffic accident and fire outbreak occurrences are perceived to be higher than oil spillage and noise pollution. To show whether there is a significant difference in the rating of environmental impacts of fuel transportation by road, a chi square test was employed. The result shows that respondents that rated traffic accident and fire outbreak high are significantly different from those that rated traffic accident and fire outbreak low with a chi-square value of (280.351, 107.968) and p-value < 0.005 (0.000) respectively. This shows high level of agreement by respondents.

The result for rail transportation shows that traffic accident and noise pollution are perceived to have a high impact on the environment with chi-square value of 117.104 and 5.870 with p-

value < 0.005 (0.000 and 0.015) respectively while oil spillage and fire outbreak are rated low with chi-square value of 103.539 and 136.490 with p-value < 0.005 (0.000 and 0.000) respectively. The results imply that there is high level of agreement among the respondents in their perception of environmental impacts of fuel transportation through rail.

The result of chi square for pipeline shows that the respondents generally agreed that three out of four perceived environmental impacts of pipeline transport are high. Only noise pollution was rated low by the respondents. The chi square values as presented in the table show that rating is also statistically significant. The results of respondents' rating of environmental impacts of fuel transportation by water revealed that water transport has the least perceived environmental impacts. Out of four identifiable environmental impacts, only oil spillage is rated high by the respondents while all others were considered low. The results of chi square also show there is no disagreement among the respondents on their rating of the perceived impacts of fuel transportation through water.

2.4 Petroleum Products Distribution in Nigeria

Distribution is the actual movement of goods and services from the source of supply to the ultimate consumer (Onah & Thomas, 2004). Distribution makes the time, place and possession of utilities possible. This why it is often said that production is not complete until the goods produced gets to the final consumer (Ehikwe & Ngwoke, 2013). Figure 3 shows the distribution channels and the physical flow of petroleum products in Nigeria.

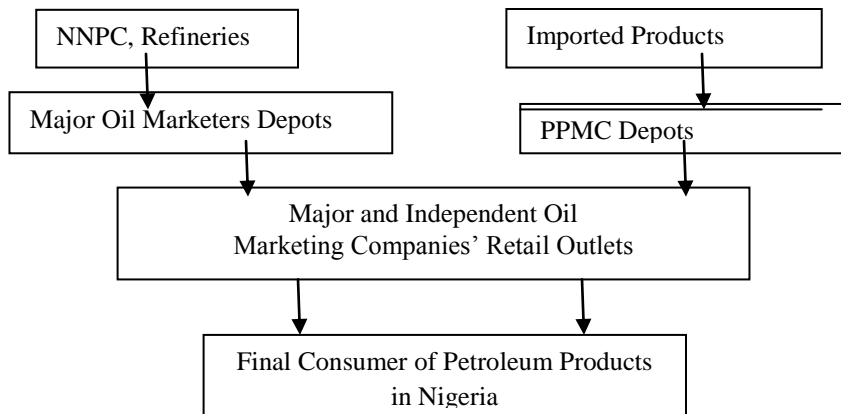


Figure 3: Distribution Channels of petroleum products
Source: NNPC/PPMC Bulletin 2010

Petroleum products are imported or refined locally and received by the PPMC through the import jetties and pipelines and distributed through the pipeline network to various depots strategically located across the country. These are referred to as “bridging depots”. The last channel of distribution is the retail outlets through which final consumers are reached. Until recently, the distribution was a problem, because many states used to experience shortage of the refined petroleum products. Table 5 shows the volume of petroleum products distributed throughout six geo-political zones in the country.

Table 6: Petroleum Products Distribution by Zone in 2014 (in Litres)

Products	South West	South East	South South	North West	North East	North Central	FCT	Total
LPG	-	-	-	-	-	-	-	-
PMS	5,985,582.05	1,191,951.06	3,076,045.99	2,433,049.15	1,650,900.94	1,455,407.33	1,606,540.05	17,399,476.63
HHK	1,370,667.45	319,839.24	685,252.63	190,290.50	84,617.05	179,376.56	54,078.69	2,884,122.12
ATK	381,071.63	-	-	-	-	-	-	381,071.63
AGO	1,749,449.62	116,334.84	981,514.29	157,671.49	44,147.77	121,368.93	48,676.79	3,219,163.71
LPFO	-	-	-	-	-	-	-	-
Lubricating Oils	-	-	-	-	-	-	-	-
Greases	-	-	-	-	-	-	-	-
Pet Jelly/Waxes	-	-	-	-	-	-	-	-
Bitumen & Asphalts	-	-	-	-	-	-	-	-
Brake Fluids	-	-	-	-	-	-	-	-
Special Products	-	-	-	-	-	-	-	-
Gas Appliances	-	-	-	-	-	-	-	-
Chemicals	-	-	-	-	-	-	-	-
Others (LRS,SRG)	-	-	-	-	-	-	-	-
Total	9,486,770.75	1,628,125.15	4,742,812.90	2,781,011.14	1,779,665.76	1,756,152.88	1,709,295.52	23,883,834.09
% Distribution	39.72	6.82	19.86	11.64	7.45	7.35	7.16	100.00

Source: NNPC Annual Statistical Bulletin 2014

As revealed in Table 6, about 23,883,834.09 litres of different petroleum products were distributed to six geo-political zones in 2014. About 39.72% of this volume was distributed and consumed in the South-West zone while the South-South zone consumed 19.86%. The South-East consumed the least of the fuel, only 6.82%. The most widely used product is PMS; constituting 72.85% of all the products supplied and distributed in 2014.

2.5 Problems of Petroleum Products Transportation and Distribution

Transportation and distribution of petroleum products in Nigeria is associated with a number of problems. The first one is the gross under-utilisation of the country's refineries production capacities. The country's four refineries have been producing below their production capacities. This compels the government to resort to importation of the products, consequently draining the county's foreign exchange earnings. The reasons for low capacity utilisation include frequent break downs of refineries due to poor maintenance and

inadequate supply or allocation of crude to the local refineries for production of the refined products (Christopher & Adepoju, 2012). The second major problem is the high rate of pipeline vandalism which had been earlier discussed. These acts of economic sabotage constitute a major challenge to effective and efficient transportation and distribution of petroleum products in Nigeria.

The issue of uniform pump price across the country is another major challenge in the downstream sector of the oil industry in Nigeria. During the first 50 years of petroleum production in Nigeria, government was not involved in the pricing and distribution of the refined products. But in 1973, government began to regulate the pricing by introducing uniform pricing across the country. This was done ostensibly to promote even development. Today, this policy has become an economic burden to Nigerian government as huge amount of public funds are spent to pay subsidies for the purpose of maintaining price uniformity. Attempts to remove the subsidy and allow market forces to determine the pump price of the refined products across the country have been met with stiff opposition from labour unions, particularly the Nigerian Labour Congress (NLC).

Another problem associated with refined product distribution is the cross-border smuggling of the products especially to the neighbouring countries like Niger, Benin, Chad and Cameroon. Related to this problem is the insatiable desire of fuel retailers with connivance of Petroleum Task Force operatives to cheat fuel consumers. Hiking of pump price, false metering and adulteration of the products to unsuspecting consumers are other problems associated with fuel distribution in Nigeria.

3. Policy Recommendations and Conclusion

This study considered the environmental impacts and challenges of fuel transportation and distribution of petroleum products in Kaduna metropolis, a major city in Nigeria. The findings of the study lead us to recommend that the government should introduce measures to minimise the negative externalities associated with modes of transporting petroleum products across cities in Nigeria. The best mode with comparative economic advantage should be used for fuel transportation and distribution. As discussed earlier, pipelines are the most suitable mode for transportation of the products from the refineries and ports to various depots across the country. Roads should be used as a feeder or complementary mode of transport for final distribution of the products to the retail outlets. The current dominance of road haulage for transportation and distribution of petroleum products should be discouraged. However, to achieve this, adequate maintenance and repairs of pipeline network for products transportation and distribution should be carried out. In addition, the road transport infrastructure needs to be overhauled.

The paper has examined the perceived environmental impacts of refined petroleum products transportation and distribution in Nigeria. The dominance of road transport for transportation and distribution of refined petroleum product in spite of its high negative externalities does not augur well for Nigeria's economy. Therefore, various policy measures recommended in this paper are worthy of consideration if the country must overcome the current challenges of fuel transportation and distribution as well as reducing the negative externalities of fuel transportation and distribution in the country.

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