



Review of CNG adoption for transportation and its potential impact on fossil fuel demand in Nigeria

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Abstract

Having realized the problem caused by fuel subsidy removal and reduction in purchasing power, the Nigerian government attempted to solve this problem with the introduction of Compressed Natural Gas (CNG). The CNG is acclaimed to be cheaper and environmentally friendly. The objectives of this study to examine the rate of adoption, assesses CNG's influence on the demand for fossil fuel and lastly, to identify the challenges facing the implantation of CNG adoption. Survey of data collected from CNG stations located at Benin in Edo, Kwara, Ibadan and Abuja and Kaduna were through systematic sampling technique. Descriptive statistics showed the adoption rate and Cross-elasticity of demand revealed whether or not the CNG and petrol are substitute, complementary or non-related products. Graphically, the trend of price of the products were forecasted and descriptive analysis of histogram showed the about 18 factors that are challenges to the adoption of CNG in Nigeria. Result revealed growing level of adoption among users but significant with trickle operators and truck users while CNG and petrol are substitute products, the price of CNG does not significantly affect the demand for petrol as it falls within the inelastic cross elasticity. The progressive trend suggested that, by 2030; the price of CNG and petrol may be the same and by extension CNG price increased more than petrol. The identified challenges rage from inadequate CNG station, low awareness, conversion cost, vandalism to safety issues among others. Government needs to be strategic and provide solutions to these challenges and ensure the price of CNG does not go up as predicted to have a stable economy.

Keywords: CNG; Fossil fuel; adoption, transportation, demand, Nigeria

Introduction

Compressed Natural Gas (CNG) is regarded as natural gas that has been compressed under standard atmospheric pressure into less than 1% of its volume. According to International Energy Agency (2022) CNG is majorly composed of methane which is stored in a cylinder useful transportation, power generation, industrial use and other areas of

power or energy applications. Countries like Pakistan, China, Argentina, India and Iran have adopted the use of CNG because of its environmental friendliness and reduction in reliance on fossil fuel. Some studies noted that Compressed Natural Gas is available in Nigeria and that the country possess abundant of resources to produce it (Bashir et al, 2025,

Egwuogu and Obiajulu, 2024 and Ibeneme and Ighalo (2020).

International Gas Union (IGU) (2021) affirmed that Nigeria has over 200 trillion cubic feet of Natural Gas reserves and it is 9th in the world. Nigeria has been faced with issues and challenges on crude oil export, refineries, marketers, import and pump price for a long period of time. The need to change from fossil fuel and adopt alternative cleaner and environmentally friendly fuel like CNG has been advocated by the pressure all over the world of sustainable energy (Al-Mohannad et al, 2024). A number of countries placed restrictions on the emission of carbon and due to global warming, diseases that can be caused by carbon through emission and acidic rainfall, alternative energy are been sought after globally. Aside these, the population of the world keep increasing and the demand for fossil fuel with attendant increase in price crucially requires urgent attention with alternative energies. According to Al-Mohannad et al (2024)] the leading alternative fuels or sources energy include ammonia, biofuel, hydrogen, alcohol, natural gas and electricity.

The pronouncement of the presence of CNG became apparent when President Bola Tinubu initiated Presidential CNG-Initiative for the purpose of cushioning the effect of fuel subsidy removal in Nigeria (Odeyinka, 2025). In Nigeria, strategies are on-going with the partnership between NNPC and NIPCO government owned corporation and private oil and gas company respectively to provide CNG infrastructure across strategic places in Nigeria (Adamu, 2024). According to Akinduyite (n.d.) the CNG conversion centres currently established in Nigeria is up to 216 with Abuja and Lagos having the highest centres. Oluku and Olori (2025) posited that, Nigeria stands to gain economic stability and environmental friendliness if it can adopt CNG as alternative to fossil fuel.

While different authors have researched on benefits of CNG (Egwuogu and Obiajulu, 2024), Ibeneme and Ighalo 2020, Daser-Adams et al, 2025) there is need to assess the adoption

rate and challenges involved in adopting the CNG as alternative fuel in Nigeria. This is the gap that is addressed in this paper with a view to taking strategic a measure is skewed areas of adoption and ameliorates the existing situation.

Review of Literature

Antecedents of fuel in Nigeria regarding demand showed queues at fuel stations, hoarding and selling at higher price, purported closure by the fuel station to maximize profit, selling at midnight and interventions of military, police and other security agents are resulting to chaos at fuel stations. Arising from these challenges, Nigerian government planned to introduce natural gas in 1997 which was not implemented until the policy to revisit it started again in 2020. The Federal Government, after the removal of subsidy was and has been trying to cushion subsidy effect with the introduction of CNG. Government planned to introduce 11,500 new CNG -powered vehicles for mass transit and promised to cover over 55000 within certain period of time by establishing CNG conversion centres (Odujirin and A. Adefulu, n.d).

Gerutu et al (2023) conducted a research on techno-economic analysis of the use of CNG in Tanzania. The study revealed that there is speed drop but engine-fuel enhancement and fuel savings with the use of CNG vehicles. Usiayo et al (2025) examined the literatures with reviews on adoption of CNG as alternative fuel in Nigeria with discoveries that, awareness, policy and infrastructure deficits are the factors hampering it in Nigeria. The findings from Adegboye et al (2025) reiterated the adoption as a measure to cushion the effect of criminality like bunkering, oil theft, smuggling and other crimes around fossil fuel in Nigeria.

Adamu (2024) also carried out research on the potential of CNG in Nigeria with findings revealing environmental and cost saving benefits. CNG engine possesses high octane number for better engine and combustion performance (Sahoo and Srivastava, 2021). Energy integration has been seen as the solution to the crisis of fuel in Nigeria (John, et al, 2025). CNG is better for Nigeria and will reduce the

demand for fossil fuel with its attendant challenges of environmental effect, fuel scarcity and hike in price all the time (Egwuogu and Ekeh, 2025).

Energy Transition Theory

Energy transition has been described the change of state of energy from solid like (coal) to liquid like oil to gas or natural gas and to ionic like electricity (Zou et al, 2021). Due to the fact that fuel gives energy and this energy can be used for production, cooking, distribution, transportation, heat generation and in diverse areas from factory to domestic appliances, energy transition means changing from one form of energy to another. Zero carbon agenda has given momentum and shifts to various fuel being used to propel vehicles in recent decade

(Yang et al, 2024). According to Solomon and Krishna (2011) energy has transited from firewood to coal to oil and now to renewable energy. The latest transition is lowest carbon or zero carbon with wind energy, gas, sola and hydropower and electric energy.

According to Yang et al (2024) the shift in energy will have direct and indirect influence on security, political structure, energy justice, energy governance and geopolitical structure. Not only these segments may be influenced, technological innovation, sociocultural factors, policy arrangements, market mechanism will as well be affected. The phases of energy transition as shown in Figure1 below as adopted from (Yang et al, 2024).

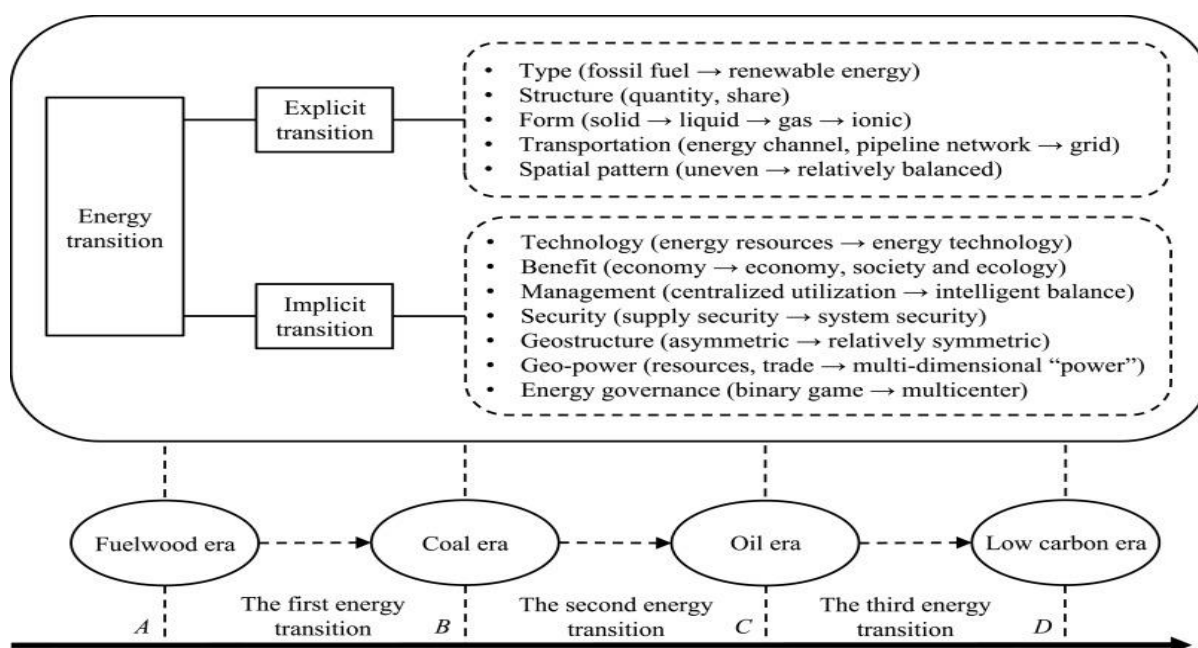


Figure1: Energy transition phases

Figure1 shows explicit and implicit energy transitions. Under the explicit is transformation from fossil fuel to renewable energy and channels of movement. This includes its structure, energy type and form. Implicitly, it cuts across complex dimensions from storage to transmission, production, consumption, management, security and governance.

Energy transition has the potential to change culture, economy, ecology and environment (Chen et al, 2019, Yang et al, 2024). The cultural change includes the manner by which

cooking is achieved, the preferences for foods, the house materials, the habit and soon because of change in the type of fuel (Mazzone et al, 2023). Dike and Charles (2024) examined the use of CNG as alternative fuel against petrol and diesel, the concern of their paper centred on environmental impact and sustainability.

In spite of the promises of CNG to the economy, environment and waste management, it is facing setbacks in distribution, fluctuations of foreign exchange affecting purchasing power of

investors, safety issues, and limited supply of gas and high cost of conversion (Odujirin and Adefulu, n.d).

Some authors opined that CNG can initiate economic stability and reduce foreign exchange or its fluctuations in Nigeria (Mazzone et al, 2023, Taiwo, 2024). Ohia (2017) discovered that comparing initial project cost and running cost of CNG gives net revenue of over N2.55 million Naira within the shortest possible period of time compare to fossil fuel. Adegoriola and Sueliman (2017) expressed the benefits of using LPG and Natural Gas with environmental friendliness and economic advantages.

While all these studies expressed the benefits, techno-economic and environmental analysis, the critical issue is whether or not the acceptance is guaranteed over certain period of time or it will have effect on demand for fossil fuel vehicles and the challenges facing the implementation of good policy initiatives. The challenges include low public awareness, infrastructure deficits, legislative issues and

conversion cost (Usiayo et al, 2025). Ogunlowo et al (2018) identified barriers to the adoption of CNG in Nigeria as: insufficient policy focus, unconducive energy market environment, poor transmission and distribution infrastructure, limited access to funding, safety concerns, insecurity, difficult Niger Delta terrain (Figure 2). Furthermore, low public awareness, lack of commitment by all and gas companies, non-inclusion of natural gas in master plan, illiterate mechanics, and many others.

In furtherance to explaining some of these barriers (Usiayo et al, 2025), the policy focus was said to be on gas flaring abatement and not on gas gathering and utilization, the energy market is not transparent and institution is full of corruption, the gas transmission and distribution pipelines which could not cover the country with an area 923,768km², it is not easy to get fund from banks with problem of volatility of Naira. Vandalism from Niger Delta and regulatory framework are the bane of CNG adoption in Nigeria.

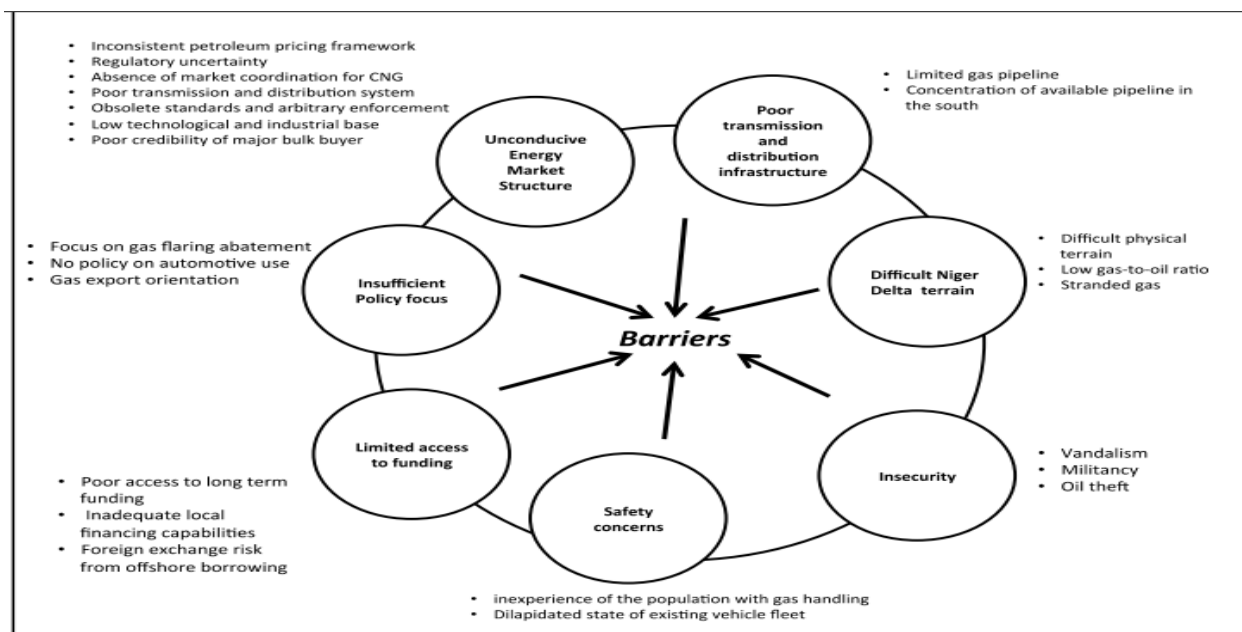


Figure 2: Barriers to adoption of CNG in Nigeria
Source; Adopted from (Ogunlowo et al,2018)

Methodology

This section deals with the adopted method to execute the research. Survey research design has been used to collect data from the CNG centres. The total population of the respondents across selected places was 403. The CNG

centres visited include Post Office in Kwara, NIPCO station along Toll Gate, Ibadan, NIPCO in Benin, CNG station Airport Road Abuja, Digate, Kaduna. The research instrument was designed questionnaire. Questionnaire is a flexible instrument of data collection and useful

to collect data from larger group of people (Jones et al, 2013). Secondary data from Daser-Adams et al (2025) was for the second objective with the used of Cross elasticity of demand.

The first objective was based on designed questionnaire asking on the state of usage and adoption by various users at the centres whether or not they are purchasing CNG at the time including the attendants. Based on research documents from Scopus indexed journals, about 18 factors were identified to be barriers, impediments or challenges as the case may be from the articles. The challenges were codified and structured into the questionnaire for respondents to answer in Likert scale. The descriptive statistics was later used to identify the hierarchy of the challenges. In order to get a sample size from the collective number of respondents, systematic sampling technique was used to administer the questionnaire.

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2} \quad \text{----- equation 1}$$

n_0 = sample size

Z = confidence level

P = estimated population

e = margin error (0.05 or 5%)

Assuming the confidence level is 95%, Z = 1.96

$$n_0 = \frac{1.96^2 \cdot 0.5 \cdot (1-0.5)}{0.05^2} = 384.16$$

For adjusted finite population of 403

$$\frac{384.16}{1 + \left(\frac{384.16}{400} \right)}$$

$$= 196.8 \text{ approximately} = 197$$

Results and Discussion

In order to achieve all the stated objectives of this study, each of the objective has been analysed using suitable analytical tools. For the adoption rate of CNG in Nigeria, respondents were asked on four nominal scale of:

- Using CNG vehicle already
- Converted to CNG,

- Use both CNG and fossil fuel,
- intending to adopt the use of CNG and not interested in CNG

Descriptive statistics has been used to show the adoption rate.

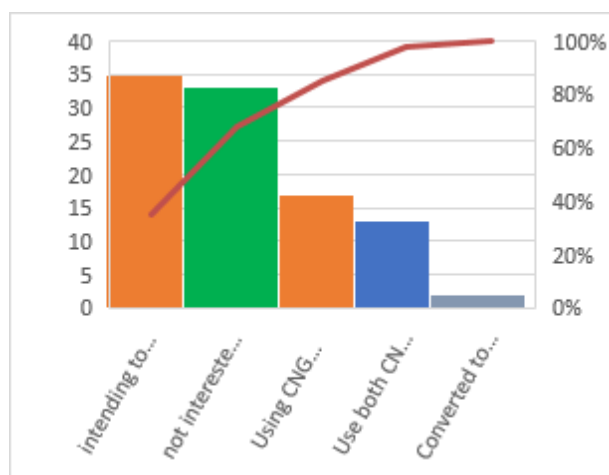


Figure 3: adoption rate of CNG in Nigeria

Figure 3 shows the statistics of CNG adoption rate among the respondents in Nigeria. 35% are already having intention to adopt CNG and 33% are not interested in CNG, 17% are using CNG vehicle already and 13% are using both CNG and fossil fuel vehicle while only 2% have converted. The indication of this statistics shows the polarization and division of people between adopting and not adopting the use of CNG as alternative fuel to petrol (PMS) in Nigeria. One third of the sampled respondents are not willing and ready to adopt the use of CNG in spite of its acclaimed cheaper price.

Conversion rate is very slow at 2% and the use of both CNG and petrol stood at 13%. While it is obvious that only 17% are currently using CNG vehicle indicating they purchased vehicles that are using CNG and that is gaining momentum in Nigeria.

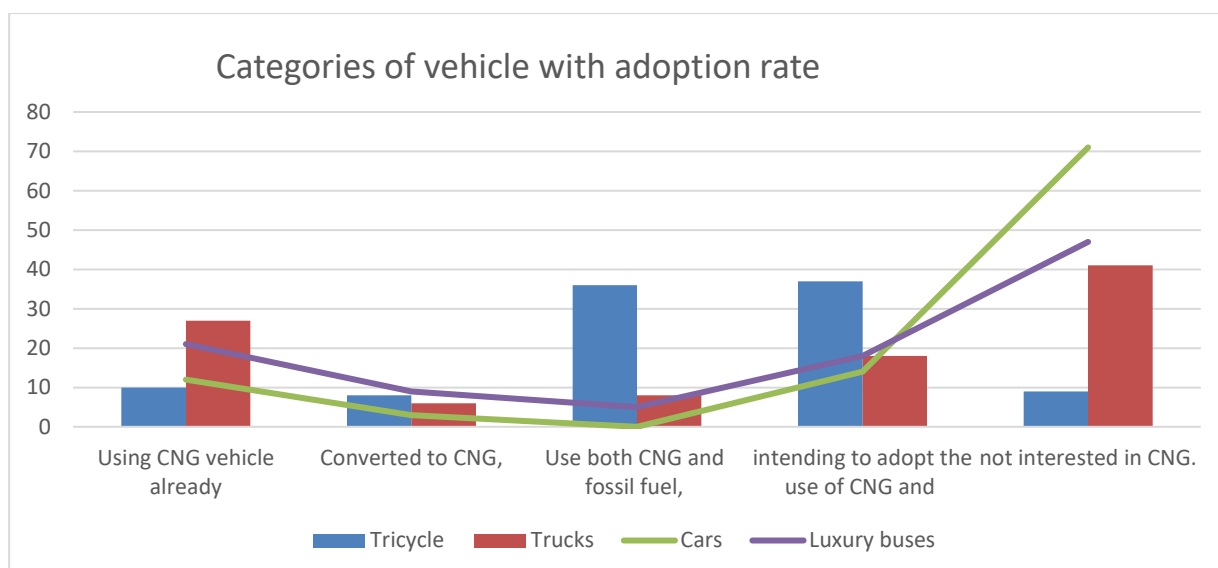


Figure 4: Categories of vehicle with adoption rate

Figure 4 shows the categories of vehicles using the CNG in Nigeria. Following the adoption rate, the next that was considered was the categories of vehicles using the CNG fuel. Tricycle and trucks seem to dominate the type or categories of vehicles using the CNG. This may be triggered by dual engine for tricycle, while environmental pollution and achievement of cleaner cum cheaper energy may also have influence in the statistics. Over the years, the conversion and use of car and buses using CNG started with hope but nosedived with intention of people to adopt CNG being revitalized as luxury buses is even more promising than cars. In order to conduct the research on the influence

Cross Elas = $\frac{\% \text{change in qty demand of A}}{\% \text{change in price of good B}}$

eqn 2

Hence, if $XED > 0$, the goods are substitute products

if $XED < 0$, the goods are compliments

if $XED = 0$, the goods are unrelated

The forecast data of both petrol (PMS demand) and CNG demand as obtained from [11] is provided in Table 1.

Table 1: Forecast Change in price of CNG and petroleum demand

Table 2 presented the elasticity of demand and price of CNG so as to achieve the objective of the study. The trend of demand for petrol has been provided as adopted from (Daser-Adams et al, 2025).

of CNG introduction on the demand for fossil fuel like petrol (PMS), cross elasticity of demand was performed. Cross elasticity of demand is measured as a % change in quantity demanded of commodity A divided by the % change in commodity B.

Table 1: Forecast Change in price of CNG and petroleum demand

The aim of the cross elasticity is to determine the extent of how the goods are substitute, complement or unrelated to each other. In this case, % change in price of CNG is considered with its influence on change % change in quantity demanded of petrol.

Year	Old price	To (New Price)	Percentage Change (%)	Year	To Year	Demand (Ltrs) From	Demand (Ltrs) To	% Change in Demand
2024	230	450	95.65%	2024	2025	18.25	18.69	2.41%
2025	450	670	48.89%	2025	2026	18.69	19.14	2.41%
2026	670	890	32.84%	2026	2027	19.14	19.59	2.35%
2027	890	1110	24.72%	2027	2028	19.59	20.07	2.45%
2028	1110	1330	19.82%	2028	2029	20.07	20.55	2.39%
2029	1330	1550	16.54%	2029	2030	20.55	21.04	2.39%
2030	1550	1770	14.19%	2030	2031	21.04	21.54	2.38%
2031	1770	1990	12.43%	2031	2032	21.54	22.06	2.41%
2032	1990	2210	11.06%	2032	2033	22.06	22.59	2.40%
2033	2210	2430	9.95%	2033	2034	22.59	23.13	2.39%

Source: Adapted from Daser-Adams et al (2025)

Table 2: Cross Elasticity of demand between CNG and PMS.

Year	Annual Demand of Petrol in Ltrs	Annual Demand of CNG in Megatonnes	% change in Petrol Demand	% change in CNG Demand	Price of petrol	CNG price	Elasticity
2024	18.25	12.41	-	-	850	230	
2025	18.69	12.71	2.41	2.42	950	450	0.0734
2026	19.14	13.01	2.41	2.36	1,050	670	0.0975
2027	19.59	13.32	2.35	2.38	1150	890	0.1185
2028	20.07	13.64	2.45	2.4	1250	1110	0.1481
2029	20.55	13.97	2.39	2.42	1350	1330	0.1683
2030	21.04	14.31	2.39	2.44	1450	1550	0.1922
2031	21.54	14.65	2.38	2.37	1550	1770	0.2151
2032	22.06	15	2.41	2.39	1650	1990	0.2422
2033	22.59	15.36	2.4	2.4	1750	2210	0.0251
2034	23.13	15.73	2.39	2.41	1850	2430	0.0489

Table 3 shows the calculation of cross elasticity as provided by equation 1.

% Change in Petrol Demand	% Change in CNG Price	Cross Elasticity (E_{xy})
—	48.89%	—
2.41%	32.84%	0.0734
2.41%	24.72%	0.0975
2.35%	19.82%	0.1185
2.45%	16.54%	0.1481
2.39%	14.19%	0.1683
2.39%	12.43%	0.1922
2.38%	11.06%	0.2151
2.41%	9.95%	0.2422
2.40%	95.65%	0.0251
2.39%	48.89%	0.0489
2.39%	48.89%	0.0489

Source: Author's computation (2025)

Noticing that the cross-elasticity values are positives and greater than 0, CNG and petrol are substitute products. This means that as the price of CNG increases, the demand for petrol will also increase. If the CNG price is reduced, the demand for petrol will reduce. However, because all the values are less than 1, it suggests that the cross-price elasticity is inelastic. This suggests that the demand for petrol is not subjected mainly to change in price of CNG. In order to present the trend of elasticity to observe the demand over the period of forecast, it was depicted with Figure 4. Apparently, the elasticity is ranging between 2.3 to 2.4 per annum. Based on our criterion, the products are

substitute products but the demand trend shows that they are not perfectly substitute products. The reason is because, the price of CNG is not actually reducing the demand for petrol. The two demands are concurrently increasing simultaneously. The introduction of CNG will not automatically substitute for petroleum products in the next ten years.

Figure 4 shows the trend of the price of the two products and suggests that, a point of convergence of the two prices may occur as it is indicated in Table 2 around 2030 where the price of CNG and price of petrol may meet.

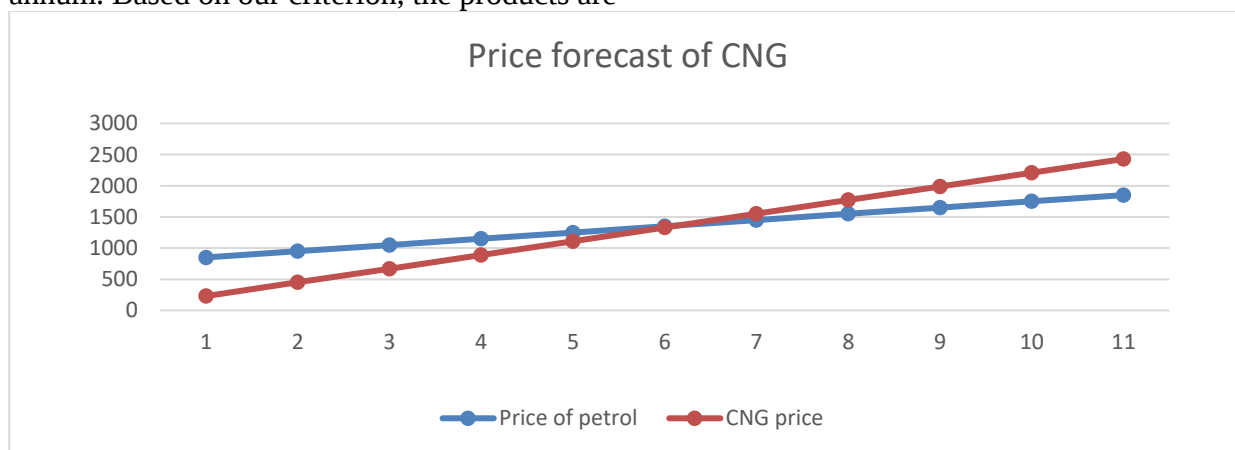


Figure 4: Price trend for CNG and PMS

Hence further, the price of CNG may exceed that of petrol according to the forecast of the data. This perhaps led to the investigation to the challenges facing the CNG adoption in Nigeria.

From the secondary data of articles mainly extracted from Scopus indexed journals, identified challenges facing CNG adoption as noted by relevant literatures (Ogunlowo et al, 2018, Oluku and Olori, 2025) and are listed below:

- a) Safety
- b) Space for load
- c) Lack of adequate CNG station
- d) Conversion cost
- e) Convenience
- f) Road infrastructure
- g) Training
- h) Trust
- i) Refueling of sudden gas exhaustion

- j) weak enforcement
- k) Naira volatility
- l) Policy deficit
- m) Low awareness
- n) Pipeline vandalism
- o) Lack of technology-know how
- p) Corruption
- q) Lack of transparency
- r) funding

Having listed the challenges, the objective here to identify the challenges through the descriptive statistics with histogram. Figure 5 presented the descriptive statistics of the challenges facing the motorist/vehicle owners to adopt the use of CNG in Nigeria.

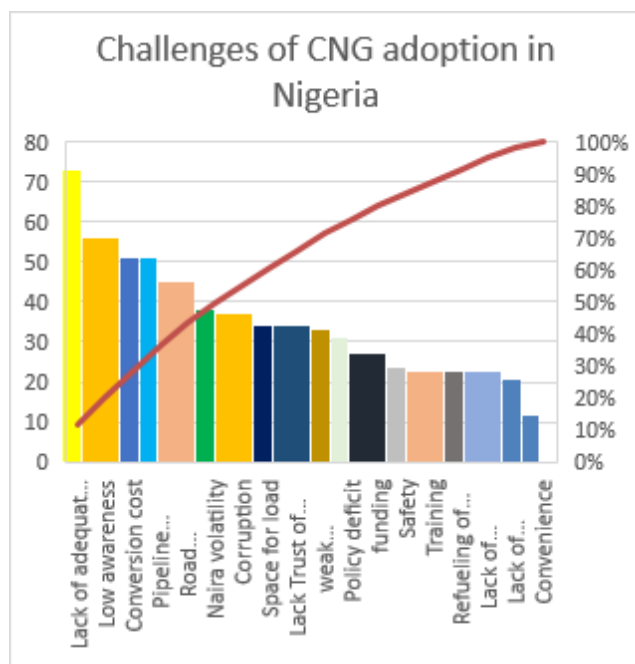


Figure 5: Challenges of CNG adoption in Nigeria

Figure 5 shows the various challenges based on the survey from the respondents of CNG adoption in Nigeria. Close to 90% of the respondents agreed that the CNG stations in Nigeria are not adequate. This represents the highest challenge according to the chart in Figure 5. The second challenge attributed to low adoption is the fact that, the awareness about CNG is low representing about 74% followed by conversion cost and vandalism which are respectively standing at about 61%. The road infrastructure challenge is another one with about 55% while Naira volatility at 48% is followed by corruption which stood at 47%. Space for load and lack of government trust on the current price of CNG have the same percentage of 43% while weak enforcement took 42%. Policy deficit, funding and safety are with 41%, 38% and 32% respectively. The challenge arising from training, gas exhaustion and technology or technical know-how carries the same percentages of 22% each. Lack of transparency in the sector and convenience of utilization that are having respective percentages of 21% and 15% are the least in the hierarchy of CNG adoption in Nigeria.

Discussion of Findings

Based on the findings of this study, the first objective was to examine the rate of adoption of CNG in Nigeria. The findings stated that, 35% are already having intention to adopt CNG, 17% are using CNG vehicle already and 13% are using both CNG and fossil fuel vehicle while only 2% have converted. Examining the analysis, if we put together those who are already using CNG, those who are using CNG with fossil fuel and those that have intention to be using the CNG, we would realize that, the combination of these figures culminated at 67% of the sampled population. This shows that, people are willing to adopt CNG because this is more than half of the population sampled. However, it is obvious that 33% are not ready and willing to adopt the use of CNG as indicated by their responses. It is a clear indication that, fossil fuel demand cannot be outrightly replaced by CNG but rather complement CNG usage in Nigeria. The tricycle users and truck users are prominent in the use of CNG while buses and cars are not fully represented in their usage at the moment.

With the use of Cross Elasticity of demand to assess CNG's adoption rate and its influence on the demand for fossil fuel in Nigeria, over the period of data forecast, the demand for CNG is not showing any reduction in the demand for petrol. This indicates that, they are relatively substitute products but the price of CNG is not significantly influencing the demand for fossil fuel (petrol). More importantly, based on the forecast, the price of CNG and petrol will meet and likely that the price of CNG will be more than that of petrol. This confirms the fear of people about the trust of government not increasing the price of CNG per cubic metre later. The obvious fact that, the price moves from 230 per cubic metre to 450 is another revelation of the fear of the people.

Regardless, since the CNG is cheaper and environmentally friendly, the barriers and challenges to its adoption should be tackled. While the tricycle owner and truck owners are seen as those patronizing the CNG more than other users, this fuel type may serve them well and others may focus on petrol as time goes-by. The important thing is for the CNG stations to

be adequate, awareness be made, conversion cost, pipeline vandalization issues should and other challenges should be looked into.

Conclusion and recommendations

This research has shown the rate of adoption of CNG in Nigeria with high level of interest by the transport service providers. However, the research revealed that CNG and petrol are substitute products but the price of CNG does not have significant influence on the demand of fossil fuel. As time goes on, the price of CNG may change and even be more than that of fossil fuel. It is good to have multiple options of fuel for different type of vehicles for the price variation and market forces.

One fundamental thing that cannot be ascertain for the users of tricycles to be the highest which can be subjected to further studies is the use of dual engines using both petrol and CNG at the same time. Again, the challenges of making CNG available must be looked into and policy framework is important to stabilize the Nigerian economy. Price and availability of fuel is very crucial to sustainable economic, social and environmental development of a nation. Nigeria needs to be strategic and get it right with abundance of natural gas and crude oil it possesses for the benefit of all Nigerians.

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