KADUNA JOURNAL OF GEOGRAPHY
2026, VOL. 8, No. 1, 451-464
https://doi.org/10.47514/kjg.2026.08.01.046

Research Article

Public Perception, Awareness, and Spatial Accessibility of Compressed Natural Gas (CNG) Infrastructure in Abeokuta South, Ogun State, Nigeria

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ABSTRACT

The shift toward cleaner alternative fuels in Nigeria has intensified following recent national reforms and diversification of the energy sector. Compressed Natural Gas (CNG) is increasingly promoted as a low-cost and environmentally preferable option for both transport and household energy use. Nonetheless, levels of awareness, acceptance, and behavioural response vary across urban contexts, particularly in rapidly expanding areas such as Abeokuta South, Ogun State. This study assessed awareness, perception, accessibility, and adoption of CNG facilities using a cross-sectional survey of 180 respondents, analyzed using descriptive statistics and chi-square tests. Findings indicate a very high awareness level (88.2%; $x^2 = 99.8$, $p<0.001$), a mixed perception of benefits and associated constraints (67.1%; $x^2 = 37.4$, $p<0.001$; $x^2 = 12.8$, $p<0.001$; $x^2 = 1.09$, $p>0.05$; $x^2 = 67.2$, $p<0.001$), but low adoption primarily attributed to high conversion costs (75.3%). Public awareness of existing government policies was also low (36%). The findings further show a linear corridor distribution of facilities, with mother stations situated at the outskirts where industrial land is available, while conversion and refilling locations cluster within high-traffic transport hubs, reflecting a demand-led expansion that improves accessibility, supports mobility, and facilitates the ongoing energy transition. Consequently, policy actions are recommended toward expanding facility networks, strengthening safety communication, and integrating CNG deployment into urban-scale planning for sustainable fuel transitions.

ARTICLE HISTORY
Submitted 4 December 2025
Accepted 6 June 2026
Published 22 June 2026

GUEST EDITOR
A. M. Ahmed

KEYWORDS
Energy Geography, Compressed Natural Gas, Public Perception, Spatial Accessibility, Abeokuta South, Energy Transition

1 Introduction

Energy geography examines the spatial organization of energy production, distribution, and consumption, with particular attention to how infrastructure, policy, and socio-environmental factors shape energy transitions (Bridge et al., 2013; Calvert, 2016). While global debates increasingly emphasize low-carbon mobility transitions, the realities of such transitions in African cities remain uneven and under-theorized. In Nigeria, discussions on alternative fuels, particularly Compressed Natural Gas (CNG), have intensified following persistent fuel import dependence, infrastructural deficits, and the 2023 petrol subsidy removal (Adewuyi & Awodumi, 2020; Onuigbo & Eze, 2024). Nigeria possesses one of the largest natural gas reserves in Africa, positioning CNG as a strategic transitional fuel for the transport sector (Nwoke et al., 2021).

The reactivation of the National Gas Expansion Programme (Federal Ministry of Petroleum Resources, 2023) reflects renewed state commitment to domestic gas utilization. However, beyond policy rhetoric, empirical evidence suggests that infrastructural inadequacy and weak public awareness continue to constrain adoption (Olanrewaju & Akintunde, 2022; Okafor et al., 2023). Existing Nigerian studies largely focus on macro-level policy analysis or technical feasibility, with limited attention to how spatial accessibility and public perception interacts at the urban scale. In medium-sized cities such as Abeokuta, these dynamics are particularly significant.

Unlike metropolitan centres such as Lagos, where energy innovations diffuse more rapidly, cities like Abeokuta experience slower infrastructural rollout and weaker sensitization campaigns. In Abeokuta South, the number and distribution of CNG refilling stations remain limited, potentially creating spatial barriers that discourage adoption. Energy transition scholarship demonstrates that infrastructure location strongly influences user behaviour, accessibility, and perceptions of reliability (Bridge et al., 2013; Calvert, 2020), yet this relationship has not been empirically examined in the Nigerian context using integrated spatial and socio-behavioural approaches. Moreover, African energy transition studies show that technology uptake is shaped not only by availability but also by trust in policy, perceived safety, affordability concerns, and prior energy experiences (Olanrewaju & Akintunde, 2022). Following subsidy removal and rising transport costs, economic pressure may increase interest in CNG; however, inadequate infrastructure and limited awareness can undermine perceived viability. Understanding this intersection is critical for effective policy implementation.

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This study addresses this gap by integrating GIS-based spatial accessibility analysis with assessment of public awareness and perception of CNG infrastructure in Abeokuta South. By grounding the analysis in Nigerian urban realities, the study moves beyond generalized global narratives and contributes localized empirical evidence to debates on energy transitions in sub-Saharan Africa. The findings aim to inform infrastructure planning, public sensitization strategies, and equitable energy transition policies within the framework of urban energy geography.

1.1 Literature Review

Energy geography conceptualizes energy transitions as spatially and socially embedded processes shaped by infrastructure distribution, governance systems, and socio-economic inequalities (Bridge et al., 2013; Sovacool et al., 2022). Socio-technical transition theory further explains that energy transitions emerge through interactions among technologies, institutions, users, and markets across multiple levels (Geels, 2002). Within this framework, Compressed Natural Gas (CNG) adoption in Nigeria can be viewed as a niche innovation attempting to reconfigure the dominant petroleum-based transport regime. Complementarily, energy justice perspectives emphasize equitable access, distributional fairness, and inclusive decision-making in energy transitions (Heffron et al., 2015), highlighting the need to assess who benefits from infrastructure rollout and who remains marginalised. Globally, CNG adoption has been supported by coordinated policy incentives, regulatory enforcement, and strategic infrastructure placement. Countries such as Argentina, China, India, and Brazil demonstrate that sustained institutional commitment and stable pricing mechanisms are central to long-term uptake (Wongwuttanasatian et al., 2022). These experiences indicate that technical feasibility alone does not ensure adoption; rather, infrastructural accessibility, regulatory certainty, and user trust are decisive.

In Nigeria, the removal of petrol subsidies in 2023 significantly reshaped the transport energy landscape. In response, the Federal Government strengthened the Presidential Compressed Natural Gas Initiative (PCNGI) to accelerate CNG conversion and infrastructure deployment. By 2025, over 65 CNG refuelling stations were operational nationwide, supported by concessionary pricing frameworks and public–private partnerships (Ariemu, 2025; PCNGI, 2025). The Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) also reported a 2,500% increase in CNG conversion capacity in 2024, reflecting rapid niche expansion within the transport energy regime (NMDPRA, 2025).

Recent Nigerian scholarship suggests that despite policy momentum, infrastructural distribution remains uneven across states, reinforcing spatial disparities in access (Ekiti et al., 2025). Furthermore, adoption decisions are influenced not only by fuel cost considerations but also by trust in policy consistency, perceived reliability of supply, and proximity to refilling stations (Muhibbudin, 2025). These findings align with energy justice arguments that equitable infrastructure placement and transparent governance are essential for legitimate transitions. However, most Nigerian studies remain national in scope, focusing on macroeconomic feasibility and environmental implications. Limited research integrates Geographic Information Systems (GIS) analysis of station distribution with socio-behavioural assessments at the urban scale. Medium-sized cities such as Abeokuta, therefore, remain underexplored in the literature. Addressing this gap is essential for understanding how spatial accessibility and public perception jointly shape CNG adoption within Nigeria's evolving socio-technical energy transition.

1.2 Theoretical Framework

This study adopts an integrated theoretical framework that combines Socio-Technical Transition Theory (STT) and Cognitive Dissonance Theory (CDT), while drawing on Energy Justice as an analytical lens for assessing spatial equity in infrastructure provision. The framework recognizes that the adoption of Compressed Natural Gas (CNG) is not determined solely by economic considerations or technological availability, but by the interaction of institutional structures, infrastructure accessibility, and individual behavioural responses. By integrating these perspectives, the study provides a multi-level explanation of how structural and cognitive factors jointly influence the transition from conventional petrol-based mobility to cleaner energy alternatives in Abeokuta South.

Socio-Technical Transition Theory explains how energy transitions occur through interactions among technologies, infrastructures, regulations, markets, and user practices (Geels, 2002). Established energy systems are often stabilized within dominant socio-technical regimes that shape patterns of production and consumption. In Nigeria, petrol-based transportation represents such a regime, reinforced by decades of subsidy support, extensive distribution networks, and widespread consumer familiarity. The removal of fuel subsidies in 2023 created a significant landscape-level disruption that increased interest in alternative fuels such as CNG. However, transition theory suggests that policy reforms alone do not guarantee adoption. The diffusion of new technologies depends on the extent to which supporting infrastructures, institutional arrangements, and market conditions align with user needs.

Consequently, limited refilling stations, inadequate distribution networks, and regulatory uncertainties may constrain the expansion of CNG despite favourable policy

intentions. While STT explains the structural conditions shaping adoption, Energy Justice provides a complementary perspective for assessing whether the benefits of the transition are equitably distributed across space and social groups. Energy Justice emphasizes fairness in access to energy services and infrastructure (Heffron et al., 2015). Within the context of CNG deployment, distributional justice is particularly relevant because unequal access to refilling stations may create barriers for residents and transport operators located outside major commercial corridors.

Spatial disparities in infrastructure provision can increase travel distances, inconvenience, and transaction costs, thereby discouraging participation in the transition process. Furthermore, although CNG may offer long-term economic benefits through reduced fuel expenditures, the initial costs associated with vehicle conversion may disproportionately affect lower-income users. Accordingly, GIS-based accessibility analysis provides an important means of evaluating whether CNG infrastructure is distributed in a manner that promotes inclusive participation in the emerging energy transition. At the individual level, Cognitive Dissonance Theory explains how people respond when their beliefs and behaviours are inconsistent (Festinger, 1957). Individuals often experience psychological discomfort when they recognize the advantages of a particular action but fail to act accordingly.

In the context of CNG adoption, residents and transport operators may acknowledge the economic and environmental benefits of CNG while continuing to rely on petrol. Such inconsistencies may arise from concerns about conversion costs, safety perceptions, maintenance requirements, or uncertainty regarding the long-term sustainability of government policies. Rather than changing behaviour, individuals may rationalize continued petrol use by emphasizing perceived risks or practical constraints. This perspective is particularly useful for interpreting situations in which awareness of CNG is high but actual adoption remains limited. The integration of these perspectives provides a comprehensive explanation of CNG adoption patterns in Abeokuta South.

The framework posits that adoption outcomes emerge from the interaction between structural opportunities and behavioural responses. For instance, high levels of awareness accompanied by low adoption rates may reflect a combination of inadequate infrastructural support, unequal spatial access to refilling facilities, and behavioural hesitation arising from perceived risks and costs. In such circumstances, non-adoption cannot be attributed solely to a lack of information or resistance to innovation. Rather, it reflects the combined influence of socio-technical constraints, spatial inequalities, and cognitive processes. The framework, therefore, enables a more nuanced interpretation of the transition to CNG by linking infrastructure geography, accessibility, equity, and user behaviour within a single analytical model. Such an approach is particularly relevant for understanding urban energy transitions in rapidly growing African cities, where technological change is often shaped by both systemic conditions and everyday decision-making processes.

2 Materials and Methods

2.1 Study Area

Abeokuta South Local Government Area (LGA) is located in Ogun State, Southwestern Nigeria, within the rapidly expanding Abeokuta metropolitan region (Figure 1). The LGA lies approximately between latitudes 7°05′N and 7°20′N and longitudes 3°17′E and 3°27′E, occupying a strategic position on the eastern bank of the Ogun River. It forms part of the Ogun Central Senatorial District and serves as one of the major urban and commercial centres in Southwestern Nigeria (Ogun State Government, 2023; Akinyemi et al., 2022). The administrative headquarters is located at Ake, a historically significant district that has played a central role in the socio-economic development of the city. Abeokuta South constitutes the urban core of the Abeokuta metropolis and has experienced substantial population growth and spatial expansion over the past three decades.

Rapid urbanization, increasing commercial activities, and expanding residential developments have intensified transportation demands across the metropolis (Oduwaye et al., 2021; Adewuyi & Olofin, 2023). Major districts within the LGA include Ake, Ijemo, Itoku, Ijeja, Adatan, Kuto, Oke-Ilewo, and Asero, which collectively host a concentration of administrative, commercial, educational, and industrial activities. The area's transportation network consists of major arterial roads, collector roads, and feeder routes that facilitate both intra-city and inter-city mobility. Key transport corridors connect Abeokuta South with major urban centres such as Lagos, Ibadan, and Sagamu, making the LGA an important transportation hub within Southwestern Nigeria (Adebayo et al., 2024). These characteristics make the area particularly suitable for assessing the adoption potential and spatial accessibility of Compressed Natural Gas (CNG) infrastructure in urban transportation systems.

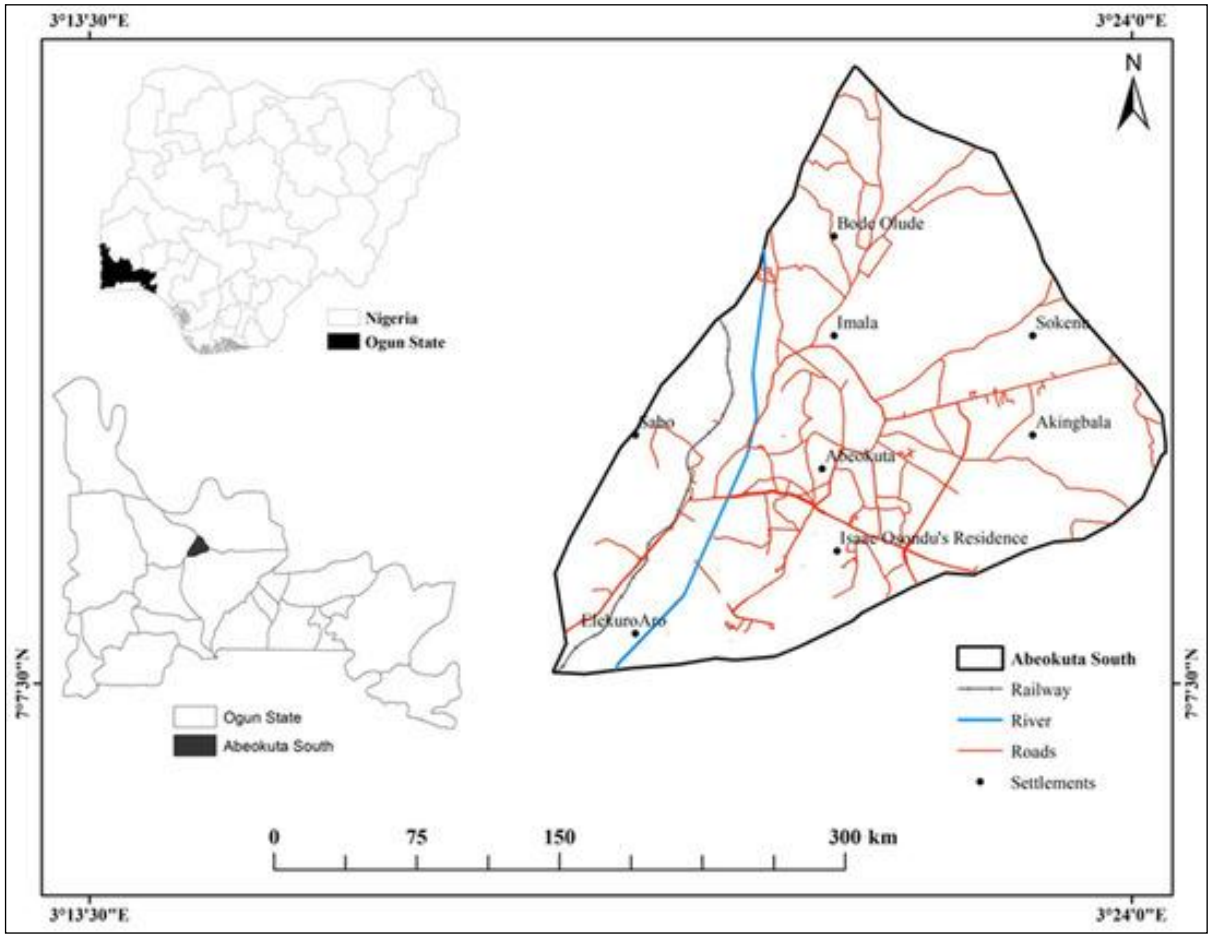

Figure 1: Map of Abeokuta South
Source: Adapted from Bilintoh et al., 2022.

Geologically, Abeokuta South is situated within the Precambrian Basement Complex of Southwestern Nigeria, which forms part of the African crystalline shield. The underlying geology consists predominantly of migmatite-gneiss complexes, quartzites, schists, granites, and charnockitic intrusions that have undergone extensive tectonic deformation and metamorphism (Bello & Oriaje, 2019; Oladejo et al., 2022). The terrain is characterized by undulating topography, isolated inselbergs, and prominent rocky outcrops, including the famous Olumo Rock, which constitutes a major geomorphological landmark and tourist attraction within the metropolis. These geological formations influence land-use patterns, urban expansion, drainage characteristics, and infrastructure development across the study area (Akinluyi et al., 2021). The LGA is bounded by Abeokuta North Local Government Area to the north, Obafemi-Owode Local Government Area to the south, Sagamu Local Government Area to the east, and neighbouring peri-urban settlements toward the western axis. Its strategic location within Ogun State has contributed significantly to its role as a regional economic and transportation node (National Population Commission, 2023).

Climatically, Abeokuta South falls within the tropical wet-and-dry climatic zone of Southwestern Nigeria. The area experiences two distinct seasons: a wet season extending from March to October or early November and a dry season occurring between November and February. Mean annual rainfall ranges from approximately 1,100 mm to 1,500 mm, while average annual temperatures vary between 26°C and 30°C (NIMET, 2023; Olaniran et al., 2022). The dry season is influenced by the northeast trade winds, resulting in the Harmattan phenomenon, which is characterized by cool temperatures, reduced humidity, dust-laden air, and hazy atmospheric conditions between December and January. Climatic conditions influence transportation activities, fuel consumption patterns, and urban environmental quality, making them relevant considerations in sustainable mobility planning.

Socio-economically, Abeokuta South is one of the most vibrant commercial centres in Ogun State. The local economy is driven by trade, public administration, transportation services, small-scale manufacturing, education, and traditional crafts. The area is internationally recognized for its production of Adire textiles, a traditional Yoruba tie-and-dye fabric that has become an important cultural and economic asset (Bello & Oriaje, 2019; Adepoju & Adebisi, 2022). Major commercial centres such as Itoku Market and Adire International Market attract traders and visitors from across Nigeria

and beyond. The concentration of commercial activities, high vehicular movements, and growing urban population have contributed to increased energy demand and transportation-related emissions, highlighting the need for cleaner and more sustainable transport alternatives such as CNG (IAEA, 2024; Adebayo et al., 2024).

2.2 Research Design

A cross-sectional survey design was adopted. The target population comprised vehicle owners, commuters, commercial drivers, and household users within Abeokuta South.

2.3 Sample Size and Sampling Procedure

Using Cochran's formula, an initial sample size of approximately 400 respondents was targeted for the study (Cochran, 1977). A multi-stage sampling technique was employed, covering wards, markets, motor parks, and residential areas to ensure comprehensive coverage of the study population (Kothari, 2004). However, due to practical fieldwork constraints, including limited accessibility to respondents along the selected transport corridors, time restrictions, and financial considerations, the final sample was adjusted to 180 respondents (Israel, 2013). This reduction was further justified by the relatively smaller population of active users and operators within the corridors, and the application of the Finite Population Correction (FPC) supported the methodological appropriateness of the smaller sample (Cochran, 1977; Levy & Lemeshow, 2013). To maintain representativeness, the 180 respondents were proportionately distributed across the three corridors, aligning with standard practices in transportation and mobility research (Bhattacherjee, 2012). Consequently, despite the reduction, the sample size remained statistically valid and sufficient to achieve the study's research objectives.

2.4 Data Collection Instrument

A structured questionnaire was used to collect data on respondents' socio-economic characteristics, level of awareness of CNG, perceptions of its benefits and challenges, factors influencing adoption and use, the role of government policies and awareness campaigns, and strategies for improving the accessibility and utilization of CNG facilities. Awareness and perception variables were operationalized using binary (dichotomous) response categories (e.g., Yes = 1, No = 0). The use of binary coding was considered appropriate because the study primarily sought to determine whether respondents possessed awareness of CNG and whether they held favourable or unfavourable perceptions regarding its adoption. Dichotomous measures also facilitate straightforward interpretation and are compatible with logistic regression and other categorical analytical techniques commonly used in adoption studies (Hosmer et al., 2013). However, it is acknowledged that binary measures may oversimplify respondents' views by failing to capture variations in the intensity or degree of awareness and perception. Consequently, the findings should be interpreted as reflecting the presence or absence of awareness and perceptions rather than the strength of those attitudes. Future studies may employ Likert-scale measures to provide a more nuanced assessment of public attitudes toward CNG adoption.

2.5 Analytical Techniques

Descriptive statistics (frequencies and percentages), and inferential statistics (Chi-square tests of Independence) were employed. Reliability test: Cronbach's alpha = 0.82.

3 Results

3.1 Socio-Economic Characteristics of Respondents in Abeokuta South

The gender distribution of respondents indicates a higher participation of females in the study area (Table 1). Out of the 180 individuals surveyed, 117 (68.2%) were female, compared to 63 males (31.8%). This suggests that women were more accessible or more willing to participate in the survey compared to men. Such a gender skew may also reflect the demographic composition of the study area or differences in daily activity patterns that influenced respondents' availability.

The age structure, as presented in Table 1, reveals that the sample is dominated by young adults. More than half of the respondents (52.9%) fall within the 18–25-year age group, followed by 17.6% in the 26–35 category. Respondents younger than 18 years constituted 12.9%, while those aged 36–45 and 46 years and above accounted for 11.8% and 4.7% respectively. This youthful age profile suggests that the study population is active, dynamic, and likely influenced by contemporary social and economic trends.

Table 1: Socio-Economic Characteristics of Respondents in Abeokuta South

Variables	Frequency	Percentage (%)
Gender of Respondents		
Male	63	31.8
Female	117	68.2
Age of Respondents		
Less than 18 years	21	12.9
18-25 years	96	52.9
26-35 years	30	17.6
36-45 years	24	11.8
46 and above	8	4.7
Educational Level		
Primary education	7	3.5
Senior school certificate	33	16.5
OND/NCE	70	38.8
Bachelor's degree	62	35.3
Master Degree	12	5.9
Occupation		
Business owner	9	4.7
Office owner	14	7.1
Government employee	30	15.3
Artisan	7	3.5
Student	113	65.9
Unemployed	7	3.5
Total	**180**	**100**

Educational attainment also shows a relatively well-educated population. A large proportion of respondents reported having OND/NCE qualifications (38.8%) or a Bachelor's degree (35.3%). Those with a Senior School Certificate made up 16.5%, while only a small fraction had primary education (3.5%). Respondents with a Master's degree accounted for 5.9%. This pattern indicates that the study area has a substantial number of individuals with tertiary education, which may shape their awareness, decision-making, and socio-economic behaviour.

The occupational distribution reflects a population dominated by students, who constitute 65.9% of respondents. Government employees (15.3%) comprise the second-largest group, followed by office owners (7.1%) and business owners (4.7%). Artisans and unemployed individuals each represent 3.5% of the sample. The predominance of students corresponds with the youthful age structure and suggests that educational institutions may be central to the socio-economic activities of the area.

3.2 Assessment of the Level of Awareness of Compressed Natural Gas Facilities among the Respondents in Abeokuta South

Table 2 shows the respondents' level of awareness of compressed natural gas (CNG) facilities within the study area. The findings reveal a very high level of general awareness, as 88.2% of the respondents reported having heard about CNG as an alternative fuel source, while only 11.8% indicated no prior knowledge. This suggests that CNG is not a completely new concept among the targeted population and that information about alternative fuels has reached a significant portion of the community.

Further results indicate strong awareness of existing CNG infrastructure. A majority of the respondents (85.9%) stated that they know at least one CNG refueling station in the study area, while 14.1% do not. In addition, 78.8% reported having seen a vehicle that operates on CNG, which reinforces the visibility of CNG-powered transportation within the locality. These results imply that the adoption of CNG is not entirely abstract to the population; rather, it is supported by observable evidence of its use. Awareness of the benefits associated with CNG use is also considerably high. About 71.8% of respondents claimed to understand the advantages of CNG over conventional fuels such as petrol and diesel, compared to 28.2% who did not. Similarly, 85.9% reported having received some form of formal or informal education on CNG and its facilities. This high level of exposure reveals that both institutional and informal information channels are contributing to public knowledge about CNG. Chi-square goodness-of-fit analysis revealed that awareness of CNG facilities was significantly higher than a neutral probability of 50%. Respondents showed statistically significant awareness of CNG as an alternative fuel ($\chi^2 = 99.8$, $p < 0.001$), knowledge of refueling stations ($\chi^2 = 85.4$, $p < 0.001$), exposure to CNG vehicles ($\chi^2 = 51.2$, $p < 0.001$),

knowledge of benefits ($\chi^2 = 25.7$, $p < 0.001$), and CNG-related education ($\chi^2 = 85.4$, $p < 0.001$). This indicates a strong awareness base for potential adoption of CNG in Abeokuta South.

Table 2: Assessment of the Level of Awareness of Compressed Natural Gas Facilities among the Respondents in Abeokuta South

Variables	Frequency	Percentage (%)
Heard about compressed natural gas as an alternative fuel source		
Yes	157	88.2
No	23	11.8
Know any CNG refueling station in the study area		
Yes	152	85.9
No	28	14.1
Ever seen a vehicle that operates on CNG		
Yes	138	78.8
No	42	21.2
Know the benefits of using CNG over traditional fuels like petrol or diesel		
Yes	124	71.8
No	56	28.2
Ever received any formal or informal education about CNG and its facilities		
Yes	152	85.9
No	28	14.1
Total	**180**	**100**

3.3 Evaluation of Respondents' Perception Regarding the Benefits and Challenges of Using CNG Facilities in Abeokuta South

In contrast, Table 3 shows a mixed public perception regarding the benefits and challenges of CNG adoption. Although 67.1% agreed that CNG is an environmentally friendly option, a much smaller proportion (24.7%) believed it is more cost-effective than petrol or diesel, suggesting uncertainty about its economic advantage. Safety concerns remain a major issue, with 82.4% expressing worries about the safety of CNG-powered vehicles. Additionally, while the availability of refueling stations was not considered a critical challenge by the majority (58.8%), willingness to switch remains high, as 77.6% indicated they would adopt CNG-powered vehicles if facilities were more accessible. This indicates that despite perceived challenges, there is strong potential for increased CNG use with improved infrastructure and awareness.

Table 3: Evaluation of Respondents' Perception Regarding the Benefits and Challenges of Using CNG Facilities in Abeokuta South

Variables	Frequency	Percentage (%)
Believe that using CNG is more cost-effective than petrol or diesel		
Yes	49	24.7
No	131	75.3
CNG is an environmentally friendly fuel option		
Yes	114	67.1
No	66	32.9
Consider the availability of CNG refueling stations as a major challenge for adoption		
Yes	83	41.2
No	97	58.8
Concerned about the safety of a CNG-powered vehicle		
Yes	145	82.4
No	35	17.6
Willing to switch to a CNG-powered vehicle if the facilities were more accessible		
Yes	135	77.6
No	45	22.4
Total	**180**	**100**

Chi-square goodness-of-fit tests, as shown in Table 4, were conducted to determine whether respondents' perceptions regarding CNG benefits and challenges differed significantly from an equal probability distribution. The results showed a significant rejection of the null hypothesis for most variables. Respondents largely disagreed that CNG is more cost-effective than petrol or diesel ($\chi^2 = 37.4$, $p < 0.001$), while a significant proportion agreed that CNG is environmentally friendly ($\chi^2 = 12.8$, $p < 0.001$). There was no statistically significant difference regarding whether the availability of CNG refueling stations constitutes a major challenge ($\chi^2 = 1.09$, $p > 0.05$), indicating a divided perception. However, respondents expressed strong concern about the safety of CNG-powered vehicles ($\chi^2 = 67.2$, $p < 0.001$). Furthermore, a significant majority indicated willingness to switch to CNG-powered vehicles if facilities were more accessible ($\chi^2 = 45.0$, $p < 0.001$). These findings highlight mixed perceptions: high environmental approval and willingness to adopt CNG, but persistent concerns about safety and cost-effectiveness.

Table 4: Chi-Square Goodness-of-Fit Test of Respondents' Perceptions on CNG Benefits and Challenges

Variable / Statement	χ^2 Value	df	p-value	Decision	Interpretation
CNG is more cost-effective than petrol or diesel	37.4	4	< 0.001	Significant	Respondents largely disagreed that CNG is more cost-effective
CNG is environmentally friendly	12.8	4	< 0.001	Significant	The majority agreed that CNG has environmental benefits
Availability of CNG refueling stations is a major challenge	1.09	4	> 0.05	Not Significant	Perceptions were relatively divided among respondents
The safety of CNG-powered vehicles is a concern	67.2	4	< 0.001	Significant	Strong concern about safety issues
Willingness to switch to CNG if facilities are accessible	45.0	4	< 0.001	Significant	Majority willing to adopt CNG with improved accessibility

Note: df = degrees of freedom; p < 0.05 indicates statistical significance.

3.4 Identification of Factors Influencing the Adoption and Use of CNG Facilities by Individuals and Organization in Abeokuta South

Table 5 shows the major factors influencing the adoption and use of compressed natural gas (CNG) facilities among individuals and organizations in Abeokuta South. The results indicate that cost plays a significant role in shaping adoption decisions. A large majority of the respondents (75.3%) acknowledged that the cost of converting a vehicle to operate on CNG affects their willingness to adopt the technology, while only 24.7% stated that it does not. This highlights the financial burden associated with initial conversion as a critical barrier to wider CNG uptake.

Table 5 also reveals the mixed perception of government incentives in encouraging adoption. While 44.7% of respondents agreed that government incentives would motivate them to use CNG facilities, a slightly higher proportion (55.3%) did not perceive incentives as a sufficient motivator. This suggests that although incentives are important, they may not fully address other challenges, such as safety concerns, infrastructure deficits, and conversion costs that influence public willingness to transition to CNG.

Another important factor identified is the accessibility of CNG refueling stations. A total of 61.2% of respondents indicated that the distance to the nearest refueling station affects their willingness to adopt CNG, while 38.8% said distance does not matter. This underscores the importance of infrastructural expansion, as people are more likely to embrace CNG if refueling stations are conveniently located. In addition, 54.1% of respondents noted that the lack of public awareness poses a major barrier to CNG adoption, showing the need for more targeted sensitization campaigns.

Social influence also emerged as a significant determinant of adoption. The majority of respondents (84.7%) stated that recommendations from friends, family, or colleagues would influence their decision to use CNG facilities, compared to only 15.3% who said it would not. This finding highlights the strong role of interpersonal communication and social networks in shaping energy-related behaviours. Overall, the table demonstrates that financial, infrastructural, informational, and social factors collectively influence the acceptance and use of CNG in the study area.

Table 5: Identification of Factors Influencing the Adoption and Use of CNG Facilities by Individuals and Organization in Abeokuta South

Does the cost of converting a vehicle to use CNG influence respondent's decision to adopt it	Frequency	Percentage (%)
Yes	131	75.3
No	49	24.7
Would government incentives encourage respondents to use CNG facilities		
Yes	89	44.7
No	91	55.3
Does the distance to the nearest CNG refueling station affect willingness to adopt CNG		
Yes	103	61.2
No	77	38.8
Lack of public awareness is a major barrier to the adoption of CNG		
Yes	97	54.1
No	83	45.9
Would recommendations from friends, family, or colleagues influence the decision to use CNG facilities		
Yes	150	84.7
No	30	15.3
Total	**180**	**100.0**

3.5 The Role of Government Policies and Awareness Campaigns in Promoting the Use of CNG Facilities in the study area

Table 6 highlights the role of government policies and awareness campaigns in promoting the use of compressed natural gas (CNG) facilities in the study area. A key finding is the very low level of public awareness of government policies related to CNG, with only 36% of respondents indicating awareness, while a substantial 64% reported having no knowledge of such policies. This result is particularly significant because policy awareness is often a critical driver of public participation in energy transition initiatives. The finding suggests a clear communication and policy visibility gap between government initiatives and the public. Even where supportive policies or programs exist, limited dissemination and engagement may prevent potential users from taking advantage of them. Consequently, the low awareness level may partly explain the gap observed between the relatively high awareness of CNG as an alternative fuel and its actual adoption in the study area, highlighting the need for more effective policy communication and public engagement strategies. The findings further reveal that government subsidies and incentives are widely viewed as potential drivers of increased CNG adoption. A significant majority of respondents (72%) believed that financial incentives would encourage more people to embrace CNG, whereas 28% did not share this view. This highlights the importance of economic instruments in influencing behavioural change, particularly in contexts where conversion costs and affordability remain key barriers to adoption. Awareness campaigns appear to be moderately implemented in the study area. Half of the respondents (50%) reported having come across campaigns promoting CNG use, while the other half had not encountered any. This even distribution suggests that awareness efforts have reached some segments of the population but remain insufficiently widespread. Despite this, 85% of respondents believe the government is doing enough to educate the public about the benefits of CNG, while 15% disagree, indicating a generally positive perception of existing educational efforts.

Finally, the results show strong support for stricter policy measures to enhance the transition from petrol and diesel to CNG. A large proportion of respondents (81%) believed that the government should enforce stronger policies to drive this shift, compared to only 19% who opposed such measures. This suggests that the public recognizes the importance of regulatory frameworks in accelerating clean energy adoption and may be receptive to more assertive government action aimed at promoting CNG use in the study area.

Table 6: The Role of Government Policies and Awareness Campaigns in Promoting the Use of CNG Facilities in Abeokuta South

Variables	Frequency	Percentage (%)
Aware of any government policies promoting the use of CNG in the study area		
Yes	72	36
No	108	64
Think government subsidies or incentives would encourage more people to adopt CNG		
Yes	124	72
No	56	28
Come across any awareness campaigns promoting CNG use		
Yes	90	50
No	90	50
Believe the government is doing enough to educate the public about the benefit of CNG		
Yes	150	85
No	30	15
Should the government enforce stricter policies to encourage the transition from petrol/diesel to CNG		
Yes	148	81
No	32	19
Total	**180**	**100**

3.6 Respondents' Recommendation of Strategies for Improving the Accessibility and Utilization of CNG Facilities in Abeokuta South

Table 7 shows the respondents' recommendations for improving the accessibility and utilization of compressed natural gas (CNG) facilities in the study area. The results indicate that expanding CNG infrastructure is widely supported by the population. A substantial majority (79%) agreed that increasing the number of CNG refueling stations would encourage more people to adopt CNG, while only 21% disagreed. This suggests that infrastructural availability remains a core determinant of public willingness to transition to alternative fuel sources such as CNG. Table 7 also reveals mixed perceptions regarding government financial support. Although 53% of respondents believed that government incentives or financial assistance would promote greater adoption of CNG, a notable 47% felt otherwise. This near-split response implies that while financial incentives are important, they may not be sufficient on their own to drive universal adoption. Other factors, such as safety concerns, availability of CNG-compatible vehicles, and public trust in the technology, likely interplay with financial considerations. Public education and awareness emerged as another important recommendation. A significant proportion of the respondents (67%) indicated that they would be more likely to use CNG if more sensitization programs highlighting its benefits were available, whereas 33% did not see awareness as a decisive factor. This underscores the importance of targeted information campaigns to improve knowledge, dispel misconceptions, and guide informed decision-making regarding CNG use. Finally, Table 7 shows strong support for strategic partnerships and technological advancement as key pathways for improving CNG accessibility. About 61% of respondents believed that collaboration between the government and private companies could enhance CNG availability within the area. Additionally, an overwhelming 87% recommended that vehicle manufacturers should be encouraged to produce more CNG-compatible vehicles to boost adoption. These recommendations highlight the central role of multi-stakeholder engagement and industry support in scaling up CNG utilization in the study area.

Table 7: Respondents' Recommendations of Strategies for Improving the Accessibility and Utilization of CNG Facilities in Abeokuta South

The increasing number of CNG refueling stations would encourage more people to use CNG	Frequency	Percentage
Yes	139	79
No	41	21
Should the government provide financial support or incentives for individuals and businesses to adopt CNG		
Yes	96	53
No	84	47
Would respondents be more likely to use CNG if there were more public education and awareness programs about its benefits		
Yes	115	67
No	65	33
A partnership between the government and private companies could improve CNG accessibility		
Yes	103	61
No	77	39
Should vehicle manufacturers be courageous enough to produce more CNG-compatible vehicles to promote adoption		
Yes	155	87
No	25	13
Total	**180**	**100.0**

4 Discussion of Findings

The findings of this study reinforce global evidence from both developed and developing countries on the growing awareness of Compressed Natural Gas (CNG) as an alternative fuel. With 88.2% of respondents aware of CNG and 85.9% familiar with nearby refueling stations, public knowledge in the Alagbado area appears relatively high. Similar patterns of rising awareness have been reported in countries such as India, Pakistan, and Iran, where government promotion and environmental concerns have increased public familiarity with alternative fuels (Ali et al., 2024; Munoz et al., 2022). However, the results indicate a clear gap between awareness and adoption in Nigeria. From a theoretical perspective, this outcome reflects the attitude–behavior gap commonly discussed in environmental behavior and innovation adoption frameworks, where awareness or positive attitudes toward a technology do not necessarily translate into actual usage due to structural and economic constraints.

Safety concerns remain a major barrier, as 82.4% of respondents expressed apprehension about the safety of CNG-powered vehicles. Consistent with findings from other developing contexts, public doubts are often linked to weak regulatory oversight, limited technical standards, and the availability of uncertified conversion kits (Kar et al., 2023; Holechek et al., 2022). Within the study's theoretical framework, such concerns can be interpreted as perceived risk and perceived behavioral control, which significantly influence technology adoption decisions. Where regulatory institutions are weak and safety information is limited, individuals are less likely to translate awareness into behavioral change, even when environmental benefits are recognized. Economic and infrastructural barriers further constrain adoption. A substantial 75.3% of respondents identified conversion costs as a major deterrent, while 61.2% indicated that the distance to CNG refueling stations discourages interest in adoption. These findings support broader innovation diffusion theories, which emphasize that cost, accessibility, and supporting infrastructure are critical determinants of technology uptake.

Although studies from countries such as Pakistan and India also report financial constraints among lower-income users (Ali et al., 2024), direct comparisons with higher-adoption contexts should be interpreted cautiously because policy support, energy pricing structures, and institutional capacity differ significantly across countries. Social influence and limited policy visibility also shape adoption patterns. Approximately 84.7% of respondents indicated that friends and family influence their perceptions of CNG, highlighting the role of social norms and interpersonal networks in shaping environmental behavior. At the same time, only 36% of respondents were aware of existing government policies on CNG, while 85% believed that government efforts to promote the fuel were inadequate. While countries such as Argentina and Brazil have achieved relatively higher adoption through strong policy incentives and established infrastructure, these outcomes occur within different economic and regulatory

environments.

Consequently, the Nigerian context demonstrates that even when awareness and willingness to adopt are high (77.6% in this study), adoption remains constrained by infrastructural limitations, policy visibility, and financial barriers. These findings therefore reinforce the importance of aligning awareness, institutional support, and infrastructural development to translate positive perceptions of CNG into actual adoption.

5 Conclusion

The study reveals that while awareness of Compressed Natural Gas (CNG) as an alternative fuel is high, adoption remains constrained by safety concerns, limited infrastructure, high conversion costs, and low policy visibility. Socio-economic factors, particularly age and financial capacity, influence uptake, and perceptions of cost-effectiveness remain mixed despite recognition of environmental benefits. Government engagement is perceived as inadequate, though respondents support incentives, stricter policies, private-sector partnerships, and greater availability of CNG-compatible vehicles.

The study recommends targeted interventions to address the barriers limiting the adoption of Compressed Natural Gas (CNG) as an alternative fuel in the study area. Government and private stakeholders should prioritize the development of CNG refueling infrastructure along high-traffic urban corridors, major transportation routes, and key transport hubs, where demand from commercial vehicles is highest. Expanding stations in strategic locations such as central business districts, transport terminals, and intercity highways would improve accessibility and encourage wider utilization of CNG. In addition, financial incentives should be directed particularly toward commercial drivers, including taxi operators, ride-hailing drivers, and public transport operators, to reduce the high upfront cost of vehicle conversion through subsidies, tax reductions, or low-interest loans. Targeted awareness campaigns involving transport unions, vehicle dealerships, and energy agencies should also emphasize the safety standards, environmental benefits, and long-term cost savings of CNG. Furthermore, stronger policy visibility and public–private partnerships are needed to expand infrastructure, promote vehicle conversion services, and increase the availability of CNG-compatible vehicles, thereby supporting broader adoption of cleaner and more sustainable transport systems.

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