ASSESSING THE ECONOMIC IMPACT OF COMPRESSED NATURAL GAS (CNG) IN NIGERIA

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Keywords

CNG, Dependence, Economy, Environment, Transportation

Abstract

Research Problem:
Nigeria is blessed with massive crude oil deposits and significant transportation system that relies heavily on conventional fuels such as petrol and diesel despite its negative impacts on the economy and environment.The objectives of this study are toassess the financial benefits of CNG initiatives for commuters as well as to examine the impact of CNG on the Nigerian economy.

Methods/Theory:
The study adopts theenergy economics theory as its theoretical framework of analysis usingadescriptive and exploratory research design usingboth qualitative and quantitative research methods to assess the economic impact of Compressed Natural Gas (CNG) in Nigeria. The purpose of combining qualitative and quantitative data was to provide a more nuanced and grounded understanding of the issue from multiple stakeholder perspectives: the suppliers (conversion outlets), the operators (drivers), and the end-users (commuters).

Results:
Findings revealed that the use of CNG have not resulted into tangible fare reductions for commutersand the macroeconomic benefits that is to be seen in reduced fuel import dependence and job creation are being stifled dueto failures incritical infrastructure.

Conclusion
This study set out to assess the economic impact of Compressed Natural Gas (CNG) in Nigeria, navigating the complex interplay between its significant potential and the stark realities of its adoption. The findingspresent a clear and consistent narrative; CNG holds immense promise for delivering financial savings, enhancing energy security, and contributing to a sustainable energy transition, but its current economic impact is severely constrained by a confluence of infrastructural, financial, and regulatory barriers.

Key Contributions to Knowledge:
It forms a foundation for future studies into how CNG has affected the economic conditions of both Vehicle owners and commuters in terms of transportation and its cost.
Recommendation
The study therefore recommendsa massive rollout of CNG refueling stations, andpublic-private partnerships investments to boost CNG adoption in the country.

Introduction

Nigeria's energy sector is predominantly dependent on oil, resulting in significant economic and environmental challenges. Nigeria, commonly known as the "Giant of Africa," possesses a substantial transport infrastructure, which is crucial for economic and social advancement (Oluwakoya, 2023). The transportation sector predominantly depends on traditional fossil fuels like petrol and diesel, adversely affecting the nation's economy and ecology. Substantial transformations in the structure of Nigeria's economy have transpired from independence to the present, with oil emerging as the dominant industry. Nigeria possesses a diverse array of natural resources; nonetheless, it has predominantly depended on a monoculture economy, shifting from agriculture in the pre-oil era to a fragile reliance on oil revenue (Emediegwu and Okeke, 2017). The excessive reliance on oil has resulted in vulnerabilities to price fluctuations and foreign exchange volatility, to which many oil-dependent countries, including Nigeria, are susceptible (Onoh and Ndu-Okereke, 2018).

Nigeria's crude oil constitutes more than 80% of total merchandise exports and serves as the sole source of government revenue, hence propelling the economy. The excessive reliance on oil money has led to inconsistent economic growth and insufficient development in other areas, particularly the manufacturing sector, which accounts for roughly 3% of merchandise exports (Emediegwu and Okeke, 2017). Nigeria, a leading crude oil producer, paradoxically depends significantly on gasoline imports for its refined petroleum (Onoh and Ndu-Okereke, 2018). The depletion of Nigeria's foreign exchange reserves exacerbates economic instability.

Nigeria must diversify and industrialise to mitigate its overreliance on oil. Consequently, sectors such as natural gas, renewable energyincluding solarand manufacturing possess significant potential for substantial economic growth that is both sustainable and environmentally responsible. The Nigerian government has implemented several initiatives to encourage domestic gas consumption, including the Gas Revolution agenda in 2013 and the Decade of Gas project in 2020 (Johnson, Ogulu, and Erazele, 2024). Concrete steps and efficient policy implementation are essential to convert these initiatives into practical results. Nigeria's adoption of Compressed Natural Gas (CNG) as an automotive fuel commenced in the 1990s, motivated by the necessity to address environmental concerns and to utilise its substantial natural gas supplies (Ahmed et al., 2024; Igwe et al., 2024). The effort sought to advocate for CNG as a cleaner and more economical substitute for conventional petrol and diesel, in accordance with worldwide trends towards sustainable transportation (Imam, 2024).

The Nigerian government has acknowledged the potential of CNG and has enacted various steps to encourage its usage. The initiation of

the Nigerian Gas Master Plan in 2008 represented a pivotal advancement in the promotion of domestic gas utilisation. The Gas Revolution agenda of 2013 succeeded this initiative, underscoring the government's dedication to augment domestic gas consumption. These activities indicated a transition towards acknowledging the economic and environmental advantages of natural gas and its capacity to diminish the nation's reliance on oil (Johnson, Ogulu, and Erazele, 2024). The advantages of CNG are becoming progressively acknowledged. CNG is a more environmentally friendly fuel compared to petrol and diesel; it diminishes harmful emissions and enhances air quality while presenting fewer health hazards. The benefits encompass the economic aspect, as the cost advantages of CNG compared to petrol and diesel are evident in consumer pricing (Khan, Yasmin, and Shakoor, 2015). This suggests that Nigeria may diminish its dependence on imported fuels by adopting CNG, thereby preserving foreign exchange reserves and improving energy security (Ibeneme and Ighalo, 2020).

Statement of the Problem

Nigeria has significant natural gas reserves, and the government recognises the potential of compressed natural gas (CNG) to lower fuel expenses, decrease reliance on imported petroleum, and enhance air quality; yet, the adoption of CNG has been sluggish due to numerous hurdles. This circumstance poses a challenge in evaluating the genuine economic influence of CNG in Nigeria. This difficulty is exacerbated by other factors, including inadequate refuelling infrastructure, the substantial expense of converting vehicles to CNG, insufficient public understanding of CNG's advantages, and the prevailing market dominance of conventional fuels (Igwe et al. 2024; Imam 2024). Notwithstanding the government's initiatives, such as the Presidential CNG Initiative (P-CNGi), a thorough and efficient regulatory framework to facilitate CNG adoption is absent. The amalgamation of these concerns complicates the assessment of the genuine economic impact of CNG on the Nigerian economy. The challenge is exacerbated by insufficient research aimed at measuring the economic impacts of CNG uptake in Nigeria (Imam 2024).

Consequently, a critical issue is assessing the true economic impact of CNG on Nigeria, considering its potential advantages, ongoing obstacles to adoption, and the necessity for more focused research and regulatory measures.

Objectives of the Study

To evaluate the financial benefits of CNG initiatives for commuters

To examine the impact of CNG on the Nigerian economy

To assess the role of CNG in Nigeria’s energy transition and sustainability goals

Literature Review

The utilisation of Compressed Natural Gas (CNG) as an alternative fuel for cars offers economic benefits. The conversion of petrol vehicles to natural gas vehicles has economic ramifications, and research in this domain can guide policy decisions towards a more sustainable and economically feasible transportation future (Igwe et al., 2024). Adegboye et al. (2024) emphasise the prospective advantages of CNG adoption in Nigeria, including consumer cost reductions, while also underscoring the necessity for a meticulously planned deployment to prevent economic instability. Imam (2024) examined the impact of regulatory frameworks on the adoption of CNG, whereas Adegboye et al. (2024) determined that CNG adoption enhances economic security owing to its accessibility and cost efficiency. Firms implementing energy efficiency (EE)

measures can achieve economic advantages and recognise the role of socialisation agents, such as peers and media, in promoting cleaner energy, particularly in developing nations, which may indirectly enhance the economic success of EE adoption (Dimnobi et al., 2022). This indicates that fostering awareness and disseminating success narratives can promote broader adoption and its corresponding economic benefits.

Successful adoption necessitates overcoming obstacles such as financial limitations, formulating supportive legislation, establishing requisite infrastructure, and enhancing public awareness. The evaluation of the economic ramifications of CNG in Nigeria presents a multifaceted challenge, compounded by a paucity of studies especially addressing the Nigerian environment. Although numerous studies underscore the prospective economic advantages of CNG adoption, including diminished fuel expenses for consumers, reduced dependence on imported petroleum, and potential job creation within the CNG sector (Igbojionu et al., 2019), these benefits largely remain unactualized due to a complicated interplay of challenges and policy deficiencies. A key obstacle is the insufficient CNG refuelling infrastructure, especially beyond primary urban areas, which poses issues regarding the practicality and economic viability of extensive CNG adoption (Imam 2024). The infrastructural deficit hinders precise evaluation of possible cost reductions for consumers and the overall economic feasibility of CNG. The substantial expenditure of converting current cars to CNG, exacerbated by the limited availability and high cost of conversion kits, is an additional financial obstacle, especially for individual vehicle proprietors and small-scale transport operators (Adegboye et al. 2024). This financial obstacle further conceals the actual affordability of CNG and its capacity to stimulate economic growth. Although certain studies have investigated the economic viability of CNG in particular situations, such as public transport (Igbojionu et al., 2019), a comprehensive national evaluation that encompasses the varied applications of CNG and its effects on multiple economic sectors is absent.

Research indicates a history of policy inconsistencies, ad-hoc arrangements, and implementation gaps that have obstructed the establishment of a stable and supportive environment for CNG uptake (Ahmed, Enikanolaiye, Zamani, and Onibiyo, 2024). The absence of a comprehensive, long-term policy framework complicates the prediction of the enduring economic effects of CNG and the evaluation of its role in sustainable development. Research highlights the necessity for enhanced data collection and studies aimed at assessing the economic impact of CNG in Nigeria (Imam 2024). The absence of this data restricts the capacity to perform a thorough cost-benefit analysis that precisely reflects the potential economic advantages and disadvantages linked to CNG adoption. While research examining the direct economic influence of CNG on Nigeria's GDP is limited, certain studies indicate that augmented natural gas utilisation, encompassing CNG, may substantially bolster economic growth. A study indicated that a 45% local use of natural gas might enhance Nigeria's GDP growth (Johnson, Ogulu, and Erazele, 2024). The effective adoption of CNG as an automotive fuel in Nigeria necessitates a comprehensive strategy that includes specific policies, infrastructure enhancement, and heightened public awareness (Ibeneme and Ighalo, 2020). This entails the creation of a specialised body to manage the CNG effort, the development of a comprehensive CNG refuelling infrastructure, and the introduction of financial incentives to promote adoption (Igwe et al., 2024). Confronting these hurdles and engaging in extensive research to measure the economic impacts of CNG adoption are essential actions for unlocking its complete

economic potential and promoting sustainable development in Nigeria. The use of Compressed Natural Gas (CNG) as an alternative fuel in Nigeria encounters substantial hurdles, which can be classified into infrastructure deficiencies, regulatory and policy limitations, and market acceptance issues (Imam, 2024).

A significant obstacle to the extensive use of CNG in Nigeria is the inadequate infrastructure for natural gas refuelling stations (Igwe et al. 2024). CNG stations are predominantly located in major urban centres, hindering access to this alternative fuel for potential customers in other regions. The scarcity of refuelling stations deters consumers from switching their vehicles to CNG or acquiring CNG-powered vehicles due to apprehensions over refuelling convenience (Imam, 2024). It has been proposed that CNG refuelling stations should constitute at least 10% to 20% of the petrol and diesel refuelling stations required to instill confidence in potential adopters.

Simplifying the regulatory framework for the construction and operation of CNG refuelling stations, while reducing permit costs compared to those for conventional fuels, may stimulate increased private investment. The government should use its NNPC mega station initiative to establish CNG refuelling stations in key places and contemplate the introduction of mobile CNG refuelling stations to enhance accessibility (Ibeneme and Ighalo, 2020). Moreover, there are deficiencies in the infrastructure for vehicle conversion and maintenance. The gradual adoption of CNG can be partially ascribed to a disconnect with academia and local artisans and mechanics, whose expertise in CNG technology is essential for accelerating investment and implementation (Ahmed, Enikanolaiye, Zamani, and Onibiyo, 2024). The significant lack of Technology Transfer Offices in higher education institutions impedes the dissemination of innovative technology to artisans and mechanics for vehicle conversions and diesel-operated machines (Adegboye et al., 2024).

The policy framework for CNG adoption in Nigeria has faced criticism for being influenced by a temporary Presidential Compressed Natural Gas Initiative (P-CNGi), akin to a presidential task group, rather than a more enduring agency or institutional strategy. This short-term strategy may result in inadequate reaction from the private sector, a deficiency in CNG infrastructure, and substandard refuelling stations. The lack of involvement from the Ministry of Science and knowledge in the CNG initiative raises concerns, potentially obstructing knowledge transfer (Ahmed, Enikanolaiye, Zamani, and Onibiyo, 2024). Nigeria encounters regulatory deficiencies and an absence of comprehensive norms and laws overseeing the production, distribution, and use of CNG in the transportation sector. This encompasses the lack of explicit criteria for CNG vehicles, refuelling infrastructure, safety protocols, and emissions norms, generating ambiguity for prospective investors and consumers (Imam, 2024).

The absence of a designated agency for CNG implementation as a vehicular fuel, in contrast to nations such as India, Argentina, and Brazil, further exacerbates an uncoordinated implementation strategy (Ibeneme and Ighalo, 2020). Imam (2024) identified that the primary obstacle to the advancement of the Natural Gas Vehicle (NGV) market in Nigeria is the disorganised execution, the lack of governmental involvement in establishing strategic objectives, formulating legal and regulatory frameworks, defining explicit standards, and designating accountability. There is a lack of public awareness and understanding of the advantages of adopting CNG. A significant number of Nigerians lack comprehensive knowledge regarding the cost-effectiveness and environmental benefits of

transitioning to CNG, while misunderstandings concerning its safety and performance continue to exist (Imam, 2024). The lack of a Whole Government Approach (WGA) in communicating the advantages of CNG to schools, educational institutions, craftsmen, and faith-based organisations hinders its rapid adoption (Ahmed, Enikanolaiye, Zamani, and Onibiyo, 2024). Extensive public awareness initiatives are essential to inform consumers about the enduring financial savings and environmental benefits of CNG.

The substantial expense associated with converting vehicles to CNG and the possible elevated cost of CNG vehicles relative to conventional fuel vehicles in Nigeria serve as considerable deterrents (Imam, 20204). The elevated expense primarily results from Nigeria's significant reliance on imports (Ibeneme and Ighalo, 2020). Collaborating with indigenous vehicle manufacturers such as Innoson Vehicle Manufacturing Company (IVM) to make economical CNG vehicles and financing research and development in CNG automobile production in Nigeria may contribute to cost reduction. The established market supremacy of conventional fuels (petrol and diesel) poses a significant obstacle to CNG adoption. Conventional fuels possess established distribution networks, customer familiarity, and significant political and economic leverage, hindering CNG's ability to create a presence. To counteract this market domination, persistent efforts by the government and players in the CNG business are necessary to alter consumer preferences (Imam, 2024). Apprehensions about car compatibility and safety further exacerbate reluctance among prospective users. The absence of transparent information and certification procedures for CNG conversion kits and automobiles may engender uncertainties over the technology's dependability and safety. Implementing standardised standards and safety protocols for CNG technology is essential for fostering consumer confidence (Imam, 2024).

Theoretical Framework

Energy economics is an extensive scientific discipline that employs economic theory and quantitative techniques to analyse energy markets, encompassing the production, distribution, and consumption of energy resources and commodities. It includes the examination of supply and demand dynamics, price formation, market structure, and the effects of regulatory and policy interventions on energy systems (Sweeney, 2001). The theoretical underpinnings of energy economics originate from the mid-19th century, notably with William Stanley Jevons's influential publication The Coal Question (1865), which initially underscored the economic consequences of limited fuel resources. Jevons analysed Britain's reliance on coal and foresaw the larger concerns of resource depletion and energy shortage, establishing foundational concepts for the "rebound effect" in energy efficiency research (Giraudet and Missemer, 2023). The subsequent significant advancement was in 1931 with Harold Hotelling's "The Economics of Exhaustible Resources," when he systematised the intertemporal pricing of non-renewable resources. Hotelling demonstrated that, in the context of competitive extraction, the net price (or "scarcity rent") of a depleting resource must increase at the rate of interest, a principle now referred to as Hotelling's Rule, which offers a robust framework for comprehending how resource proprietors weigh present against future extraction (Hotelling, 1991).In the early 2000s, researchers such as Ayres and Warr enhanced the idea by incorporating exergy and "useful work" into growth models. Their 2005 work "Accounting for Growth: The Role of Physical Work" illustrated that energy fluxes, in addition to labour and capital, are essential determinants of economic productivity, transforming the manner in

which economists integrate energy into macroeconomic research (Ayres and War, 2005).

Methodology

This study utilised a descriptive and exploratory research approach, incorporating both qualitative and quantitative methods, to evaluate the economic impact of Compressed Natural Gas (CNG) in Nigeria. The objective of integrating qualitative and quantitative data was to furnish a more nuanced and substantiated comprehension of the issue from several stakeholder viewpoints: the suppliers (conversion outlets), the operators (drivers), and the end-users (commuters). A mixed-methods approach was employed, utilising qualitative data from semi-structured interviews for depth and context, alongside quantitative data from questionnaires for breadth and measurable patterns. This design was selected to encapsulate both the experiential realities and the statistical trends of CNG uptake and its economic implications.

Population and Sampling

The study focused on three distinct populations within the CNG ecosystem in Nigeria:

CNG Conversion Outlets: As the primary suppliers and technical experts.

Commercial Drivers using or considering CNG: As the direct operators who bear the conversion costs and experience operational changes.

Road Users (Commuters): As the end-consumers who ultimately experience the economic impact through transport fares.

A purposive sampling technique was used to select participants who had direct experience with or exposure to CNG technology. This non-probability sampling method was deemed most appropriate as it allowed for the targeted selection of information-rich cases critical to addressing the research objectives. Cochran's sample size determination formula was employed as a benchmark for adequacy.

$$\text{Cochran's formula, } n = \frac{Z^2pq}{e^2}$$

Where;

n represents the required sample size

Z is the Z-value corresponding to the desired confidence level

P is the estimated population proportion

q = 1 – p

e is the margin of error

Using a 95% confidence level (Z = 1.96), a conservative population proportion (p = 0.5), and a margin of error of 5% (e = 0.05), the formula yields a minimum sample size of approximately 384 respondents. However, due to constraints 300 road users responded to the questionnaire.

Data Collection Methods and Instruments

Data was gathered utilising two principal instruments: interviews and questionnaires. Interviews were selected for drivers to obtain comprehensive, thorough accounts of their experiences, financial assessments, and operational difficulties. The open-ended style facilitated probing enquiries and subsequent questions, which were crucial for comprehending intricate matters such as cost-benefit analysis and perceived obstacles. All drivers were interviewed at the NIPCO CNG station located on Abuja Airport Road for refuelling and conversion.

A questionnaire was administered to one (1) CNG conversion shop in Lokoja, whereas the Abuja outlet, NIPCO CNG, opted not to participate. A comprehensive questionnaire was used to collect standardised, technical, and economic data regarding the conversion procedure. Due to the specialised character of

this group, a questionnaire facilitated uniform data collection about pricing, components, and technical difficulties. Although a single sample restricts generalisability,it offers a crucial, comprehensive case study of supply-side economics. Survey for Road Users (Commuters): Three hundred (300) road users and commuters participated in the questionnaire. A questionnaire was the most effective means to collect data from a wider cohort of end-users to assess their impressions of fare alterations, travel behaviour, and overall happiness with CNG transportation.

Findings and Discussion

This study employed a survey of over 300 public transport users across Nigeria to assess the economic impact of Compressed Natural Gas (CNG) adoption. The findings provide critical, ground-level insights into the realization of CNG's proposed benefits, revealing a significant gap between its potential and the current lived experience of commuters. The discussion is structured around the core objectives of the study.

Financial Benefits for Commuters

The primary aim of this study was to assess the economic advantages of CNG initiatives for commuters. The findings reveal a paradox: although the potential cost benefit of CNG is recognised, it has not consistently resulted in actual fare decreases for the consumer. i. Perception versus Reality of Cost Savings: In answer to enquiries regarding whether CNG-powered vehicles provide reduced fares, the results were striking, with 70% perceiving "No difference" and 29.4% conceding "Yes, slightly lower." This suggests that the reduced operational cost of CNG for car owners is not being efficiently transmitted through the value chain to consumers. This is strongly supported by qualitative remarks such as, "They charge us the same fare." There is no effect, and those utilising CNG continue to charge the same price. This corresponds with the literature that identifies the market supremacy of conventional fuels and the absence of regulatory fare advice as substantial obstacles (Imam, 2024).ii. Minimal Influence on Travel Behaviour: The premise that reduced expenses will enhance mobility lacked widespread endorsement. For 80.4% of respondents, the frequency of transport saw "No change." Among individuals who altered their habits, "I move less often" (7.6%) was more prevalent than "I move more often" (4.3%). This indicates that for the minority benefiting from savings, the principal economic effect is cost containment rather than the enhancement of economic activity through higher mobility. This research refines the assertion by Adegboye et al. (2024) that CNG adoption intrinsically affects economic security; the advantage is potential and dependent on customers achieving actual savings. iv. Latent Demand for Economical Transportation: In spite of the absence of fare differential, a significant 62% of respondents indicated a preference for CNG transportation if it resulted in lower travel expenses. This indicates a significant latent demand and a market poised to adopt CNG, contingent upon the fulfilment of economic expectations.

Impact on the Nigerian Economy: Infrastructure as the Critical Bottleneck

The secondary purpose was to assess the influence of CNG on the Nigerian economy. The results indicate that macroeconomic advantages, like less reliance on fuel imports and employment generation, are hindered by significant microeconomic deficiencies, chiefly in infrastructure. i. Infrastructure Shortfall Impeding Adoption: Contentment about the accessibility of CNG-powered transportation was minimal, with an average rating of 2.5 out of 5. The qualitative findings predominantly indicated a significant deficiency in refuelling infrastructure. Observations such as "fuelling stations are scarce, leading to delays" and references to

drivers undertaking extensive journeys (e.g., from Lokoja to Ajaokuta) to refuel directly illustrate the difficulties highlighted by Igwe et al. (2024) and Imam (2024). The infrastructure shortage elevates operational expenses and downtime for transporters, jeopardising the economic feasibility of their CNG investments and constraining the requisite scale of adoption for national economic impact. ii. Safety Concerns and Public Awareness: Numerous respondents articulated safety apprehensions, with one individual highlighting a fear that CNG vehicles possess a "tendency to explode rapidly." This underscores a substantial public awareness deficiency, which Imam (2024) recognised as a critical obstacle. In the absence of public confidence, demand is stifled, which then deters additional private investment in infrastructure and vehicle conversion, so establishing a detrimental loop that obstructs economic expansion.

iii. Confidence in Long-Term Viability: Notwithstanding present difficulties, 75% of participants asserted that broader CNG use could enhance their overall transportation experience. This public goodwill is a significant asset but depends on overcoming the current infrastructure and policy obstacles. The findings indicate that the potential for CNG to enhance GDP development, as proposed by Johnson, Ogulu, and Erazele (2024), is tangible but constrained by immediate practical limitations.

The Supply-Side Perspective: Technical and Economic Realities from CNG Conversion Outlets

This section presents the findings from questionnaires administered to CNG conversion outlets, providing a critical supply-side perspective on the technical feasibility, economic viability, and systemic challenges of the CNG transition. This data directly addresses the operational barriers and costs that underpin the adoption challenges identified by commuters and drivers.

The Primary Barrier: High Initial Conversion Costs

The primary obstacle recognised by all sources was the substantial initial expense of conversion. The statistics quantified this issue: i. For automobiles, conversions primarily occur within the ₦400,000–₦600,000 bracket. ii. For buses and trucks, expenses often surpass ₦1,000,000.

This discovery immediately supports the literature on financial obstacles (Adegboye et al., 2024) and offers a definitive figure for the "high cost" that was previously referenced only anecdotally. When enquired about the origin of these expenses, outlets largely indicated that essential components such as cylinders, regulators, and Electronic Control Units (oecus) are primarily imported. This corroborates the assertions of Ibeneme and Ighalo (2020) concerning import dependency and directly associates the conversion cost with foreign exchange volatility.

Operational Challenges: Skilled Labor and Infrastructure

i. Restricted Availability of Conversion Kits: The technicians at the outlet identified "the restricted availability of conversion kits" as a significant obstacle. This significantly affects the outlet's capacity to convert automobiles. ii. Severe Infrastructure Deficiency: The majority of business drivers assessed CNG refuelling stations as "Poorly accessible" or "Moderately accessible" on the accessibility scale. Importantly, 85% indicated that this scarcity "substantially influences" customers' conversion decisions and effects their refuelling choices. This supply-side data strongly corroborates truckers' grievances over extended refuelling trips. It affirms that the infrastructure deficit is not merely a user

irritation but a critical limitation on the entire business model of conversion outlets.

Synthesis and Theoretical Implications

From an energy economics viewpoint (Sweeney, 2001), the results demonstrate a market failure in the shift to a new energy commodity (CNG). The reduced resource costs are not effectively resulting in decreased consumer prices due to elevated transaction costs (infrastructure limitations, conversion expenditures) and an inadequately formed market structure. The "scarcity rent" linked to imported fuel (Hotelling, 1931) has not been adequately supplanted by the availability of domestic natural gas due to the limited and expensive infrastructure required for its delivery to the end-user.
The research substantiates that, as posited by Ayres and Warr (2005), energy fluxes are essential to economic activity. The inefficiency in delivering CNG's "useful work" to the transportation sector immediately limits its capacity to enhance overall economic productivity and growth. The discourse emphasises that the economic ramifications of an energy transition are influenced not alone by the resource itself but by the comprehensive socio-technical system surrounding it.

Conclusion and Recommendations

This study aimed to evaluate the economic implications of Compressed Natural Gas (CNG) in Nigeria, exploring the intricate relationship between its considerable potential and the harsh realities of its implementation. The results, derived from a comprehensive analysis of commuters, drivers, and conversion outlets, reveal a coherent narrative: although CNG offers significant potential for financial savings, improved energy security, and support for a sustainable energy transition, its present economic impact is significantly limited by a combination of infrastructural, financial, and regulatory obstacles.

The study effectively met its primary goals, demonstrating that the financial advantages for commuters are predominantly hypothetical. The expected cost savings at the pump have not been adequately transferred to the consumer, resulting in a nearly equal division in perceptions of price reductions. This signifies a market in which the reduced operational costs of CNG are either retained as profit or counterbalanced by other operational inefficiencies, rather than being utilised to enhance demand via lower prices. Thus, the analysis revealed no substantial beneficial alteration in commuter travel behaviour, highlighting that the alleged economic advantages have yet to be manifested at the consumer level.

The report highlights the infrastructure deficit as the primary constraint affecting the Nigerian economy. The acute deficiency of refuelling stations, corroborated by both drivers and conversion outlets, engenders a detrimental cycle: it dissuades vehicle conversions, hence inhibiting the expansion of the conversion business and constraining the necessary scale of adoption for significant macroeconomic influence. The substantial initial expense of conversion, exacerbated by reliance on imported kits, constitutes a significant financial obstacle that hinders wider adoption, especially among individual proprietors and small-scale transport operators.

Recommendations

A coordinated and multifaceted plan is necessary to reconcile CNG's potential with its existing reality. The subsequent recommendations are put forth:
The government must spearhead and incentivise an extensive deployment of CNG refuelling stations, focussing on principal transportation corridors and urban hubs. Public-private partnerships, using existing NNPC retail assets, and promoting private investment via tax incentives and streamlined permitting processes are essential for swiftly

bridging the infrastructure deficit. A government-initiated "Whole of Government" campaign is essential to inform the public about the long-term economic efficiencies, environmental advantages, and, importantly, the safety requirements associated with CNG technology. This initiative should focus on educational institutions, automotive repair communities, and the broader populace to elucidate the technology and foster demand. The current economic impact of CNG in Nigeria is more prospective than actual. The promise of a more economical, environmentally friendly, and secure energy future for the transportation sector is genuine, although it is hindered by substantial obstacles. Realising this potential necessitates not just political will but also a deliberate, continuous, and coordinated endeavour that encompasses the entire value chain, from the importation of kits to the customer at the bus stop. The achievement of this transition will serve as a crucial measure of Nigeria's capacity to utilise its internal resources for sustained and inclusive economic development.

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APPENDIX A

INTERVIEW QUESTIONS FOR DRIVERS (COMMERCIAL AND PRIVATE VEHICLE OWNERS)

Purpose: To capture drivers' experiences, perceptions, and economic impacts of using or considering CNG, while accommodating their time constraints with concise, open-ended questions.

General Background and CNG Usage-

1. Can you briefly describe your experience with CNG as a fuel for your vehicle? (If not using CNG, are you considering converting to CNG, and why?) –
2. What type of vehicle do you drive (commercial or private), and how often do you use it?

Financial Benefits

3. How has using CNG (or the prospect of using it) affected your fuel costs compared to petrol or diesel? Can you estimate any savings?
4. Have you noticed any changes in your overall transportation expenses (e.g., maintenance, fuel) since switching to CNG?

Economic Impact

5. Do you think using CNG has impacted your income or business profitability (for commercial drivers)? If so, how?
6. How accessible and affordable are CNG refuelling stations in your area? Does this affect your decision to use or continue using CNG?

Challenges and Barriers

7. What challenges have you faced (or expect to face) in switching to or using CNG? (e.g., cost of conversion, availability of refuelling stations, vehicle performance)
8. Are there any concerns about the reliability or safety of CNG compared to petrol or diesel?

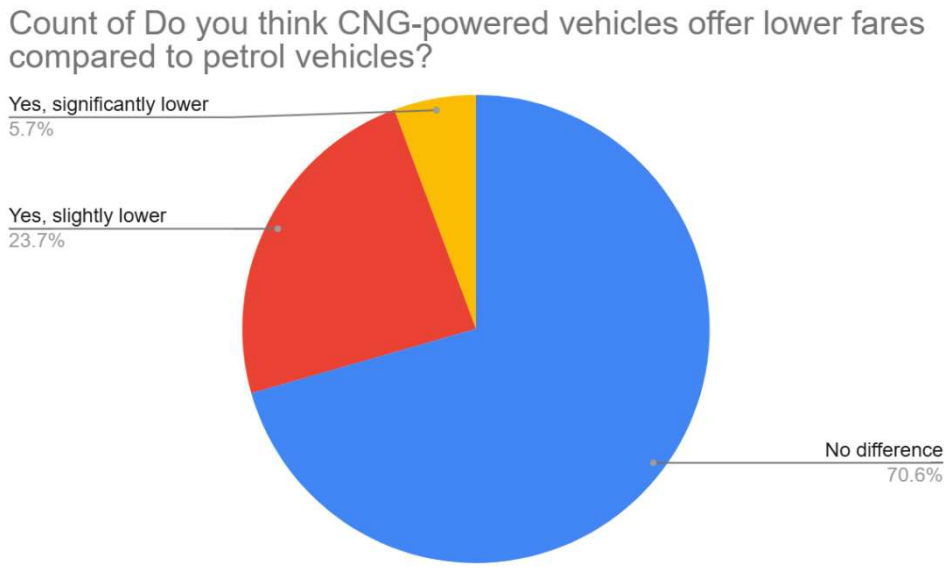
Sustainability and Awareness

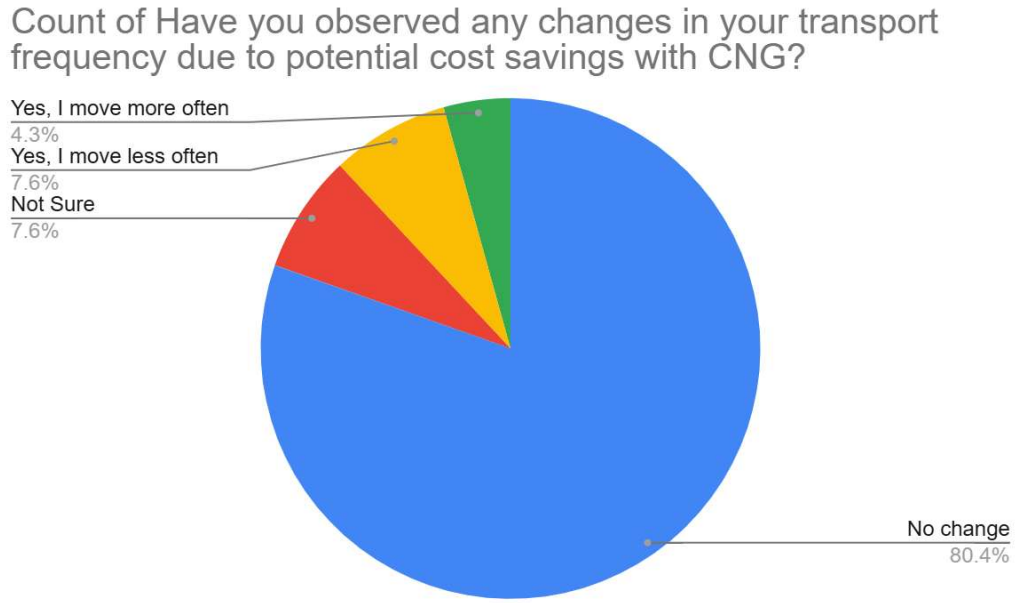
9. Are you aware of the environmental benefits of CNG, such as reduced emissions?
10. How does this influence your decision to use it?
11. Have you received any information or support from the government or other organizations about CNG adoption?
12. If so, was it helpful?

Future Outlook

13. Would you recommend CNG to other drivers?
14. Why or why not?
15. What improvements (e.g., more refuelling stations, lower conversion costs, better awareness) would make CNG more appealing to you?

APPENDIX B


Count of Do you think CNG-powered vehicles offer lower fares compared to petrol vehicles?
Yes, significantly lower
5.7%
Yes, slightly lower
23.7%
No difference
70.6%


Count of Have you observed any changes in your transport frequency due to potential cost savings with CNG?
Yes, I move more often
4.3%
Yes, I move less often
7.6%
Not Sure
7.6%
No change
80.4%