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COMPRESSED NATURAL GAS (CNG) BUS INITIATIVES AND COMMUTER ACCESSIBILITY IN DEVELOPING CITIES: A CASE STUDY OF KADUNA STATE

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Abstract

Urban transportation systems play a critical role in promoting economic productivity, social inclusion, and effective public service delivery in developing economies. Following the removal of fuel subsidies in Nigeria, transportation costs increased significantly, thereby creating mobility challenges for civil servants, students, and low-income earners who depend heavily on public transport services. In response to these challenges, the government of Kaduna State introduced a subsidized Compressed Natural Gas (CNG) bus transport initiative under the Kaduna State Transport Service to improve urban mobility and reduce transportation costs. This study examines the effectiveness of the CNG bus transport system in enhancing commuter accessibility and public service delivery within selected commuter corridors including Rigachikun–Rido, Refinery–Rigachikun, and Tudun Wada–Rigachikun routes. The study adopted a mixed-method research design combining qualitative and descriptive survey approaches. Data were collected through questionnaires, semi-structured interviews, and field observations from civil servants, students, market commuters, and transport officials across selected wards. Findings revealed that the CNG bus initiative significantly improved commuter accessibility and reduced transportation costs for residents. Government reports indicated that over 1.4 million passengers utilized the buses within five months of operation, resulting in approximately ₦1.39 billion in transport savings for commuters. However, operational challenges including irregular schedules, inadequate fleet size, overcrowding, and long waiting times reduced the overall effectiveness of the transport system. The study concludes that while the CNG transport initiative has improved affordability and commuter mobility, operational efficiency remains essential for sustainable urban transport service delivery. The study recommends increased fleet capacity, digital timetable systems, improved maintenance management, and expansion of transport routes across additional urban communities.

Keywords: Public transport policy, commuter accessibility, urban mobility, CNG buses, service delivery, urban governance.

Introduction

Urban transportation systems constitute an important component of economic development, social inclusion, and effective public service delivery in modern societies. Efficient transport

infrastructure facilitates the movement of people and goods, improves access to employment opportunities, enhances educational participation, and supports administrative productivity within public institutions. In many developing countries, however, urban mobility remains constrained by inadequate infrastructure, rising transportation costs, traffic congestion, and inefficient public transport management systems. These challenges frequently undermine workforce productivity and limit citizens' access to essential public services (Litman, 2022; World Bank, 2023). Globally, the adoption of Compressed Natural Gas (CNG)-powered buses has gained attention as a sustainable alternative to conventional petrol and diesel transportation systems. CNG buses are associated with lower operating costs, reduced greenhouse gas emissions, and improved environmental sustainability in urban transport systems (International Energy Agency, 2023). Several developing countries have adopted CNG transport systems to address fuel cost volatility and urban air pollution while simultaneously improving affordable mobility for low-income populations (UN-Habitat, 2024).

Within the Nigerian context, major urban centres continue to experience transportation challenges arising from rapid urbanization, population growth, poor transport infrastructure, and rising fuel prices. The removal of fuel subsidies in Nigeria further increased transportation costs, thereby placing considerable financial pressure on households and public sector workers who depend heavily on daily commuting. Transportation has therefore become an important determinant of workforce efficiency and public service delivery performance across Nigerian states (Adeniyi&Ojo, 2023). In response to these challenges, the government of Kaduna State introduced a subsidized Compressed Natural Gas (CNG) bus transport initiative through the Kaduna State Transport Service. The policy intervention was designed to provide affordable and environmentally sustainable transportation for residents, particularly civil servants, students, and low-income commuters who rely heavily on public transport services. The initiative forms part of broader government efforts aimed at improving urban mobility, enhancing public service accessibility, and mitigating the socio-economic effects of rising transportation costs.

Within Kaduna metropolis, the CNG bus system operates across major commuter corridors including Rigachikun–Rido, Refinery–Rigachikun, and Tudun Wada–Rigachikun routes. These routes connect residential communities with employment centres, markets, educational institutions, and government offices. Consequently, the effectiveness of the transport system has direct implications for workforce punctuality, student attendance, and overall public service

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productivity. Government reports indicate that the initiative has significantly improved commuter mobility and affordability. Reports show that over 1.4 million passengers utilized the buses within five months of operation, resulting in approximately ₦1.39 billion in transportation cost savings for residents (Maiyaki, 2025). These outcomes demonstrate the potential of subsidized public transport systems to improve urban accessibility and socio-economic welfare.

Despite these achievements, operational challenges continue to affect the reliability and effectiveness of the transport system. Commuters frequently report delays, overcrowding, irregular schedules, and limited bus availability during peak hours. These operational inefficiencies have implications for workforce punctuality and commuter satisfaction. Studies on public transportation systems emphasize that service reliability and timeliness are important determinants of commuter satisfaction and transport policy effectiveness (Cervero & Murakami, 2022; Sogbe & Susilawati, 2024). Transportation systems function as important mechanisms for public service delivery because they enable citizens to access workplaces, educational institutions, healthcare facilities, and government offices. Efficient transport systems therefore improve productivity, reduce commuting stress, and support socio-economic development. Conversely, inefficient transportation systems may undermine administrative efficiency and reduce workforce performance (World Bank, 2023).

Against this background, this study examines the effectiveness of the Compressed Natural Gas bus transport initiative introduced by the government of Kaduna State in improving commuter accessibility and public service delivery within selected commuter corridors.

Statement of the Problem

Urban transportation systems in Nigeria continue to face serious operational and infrastructural challenges resulting from rapid urbanization, inadequate transport infrastructure, traffic congestion, and rising fuel prices. Following the removal of fuel subsidies in Nigeria, transportation costs increased significantly, thereby placing financial pressure on commuters, particularly civil servants, students, and low-income earners who rely heavily on public transportation for daily mobility.

Although the introduction of the CNG bus initiative in Kaduna State was intended to improve commuter mobility and reduce transportation costs, operational challenges such as irregular schedules, inadequate fleet capacity, overcrowding, and delays continue to affect service

reliability and commuter satisfaction. These challenges may undermine the effectiveness of the transport system in enhancing public service accessibility and workforce productivity.

Furthermore, despite growing literature on sustainable urban transportation systems, limited empirical studies have specifically examined how government-subsidized CNG transport initiatives influence commuter accessibility and public service delivery outcomes within Nigerian cities. This study therefore seeks to address this gap by examining the operational effectiveness of the CNG bus transport system in Kaduna State.

Research Questions

The study seeks to answer the following questions:

- i. How does the CNG bus transport system influence commuter accessibility in Kaduna State?
- ii. To what extent does service timeliness affect commuter punctuality?
- iii. What operational challenges affect the effectiveness of the CNG bus transport system?

Objectives of the Study

The study seeks to achieve the following objectives:

- i. To examine the relationship between the CNG bus transport system and commuter accessibility in Kaduna State.
- ii. To assess the relationship between service timeliness and commuter punctuality among civil servants and students.
- iii. To determine how operational challenges affect the effectiveness of the CNG transport system.

Research Hypotheses

- i. H1: There is a significant relationship between the introduction of the CNG bus transport system and commuter accessibility.
- ii. H2: There is a significant relationship between service timeliness and commuter punctuality.
- iii. H3: Operational challenges significantly affect the effectiveness of the CNG bus transport system.

Conceptual review

Concept of Public Transportation and Urban Mobility

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Public transportation refers to organized systems designed to move large numbers of people efficiently within urban and regional environments through shared transport services such as buses, trains, and mass transit systems. Public transportation systems are central to urban development because they improve mobility, enhance accessibility to economic opportunities, and support the functioning of urban economies. Urban mobility is widely recognized as an important factor in economic development and social inclusion because efficient mobility systems enable individuals to access employment opportunities, educational institutions, healthcare facilities, and government services (Lucas, 2023).

In developing countries, public transportation systems play a particularly important role because large segments of the population depend on affordable transport services for daily commuting. However, urban transportation systems in many developing cities are characterized by congestion, inadequate infrastructure, poor route planning, and high operational costs. These challenges frequently result in unreliable transportation services and reduced accessibility for urban residents. Studies on bus transportation systems indicate that the effectiveness of public transport is strongly influenced by service quality indicators such as affordability, accessibility, reliability, service frequency, and commuter convenience (Sogbe & Susilawati, 2024). When these factors are adequately addressed, public transportation systems significantly improve commuter satisfaction and increase public transport usage.

Within the context of this study, the introduction of the Compressed Natural Gas (CNG) bus transport system in Kaduna State represents a government intervention aimed at improving urban mobility, reducing transportation costs, and enhancing public service accessibility.

Compressed Natural Gas (CNG) Transport Systems

Compressed Natural Gas transport systems refer to transport fleets powered by natural gas instead of conventional petrol or diesel fuels. CNG-powered buses have gained global attention because of their environmental benefits, lower operating costs, and improved energy efficiency. Studies show that CNG buses produce lower greenhouse gas emissions and significantly less noise pollution compared to conventional diesel-powered buses (International Energy Agency, 2023). Research on transport energy systems further indicates that CNG buses improve fuel efficiency and reduce transportation operating costs. Experimental studies on hybrid CNG buses reveal improvements in energy efficiency compared to conventional bus systems (Niewczas et

al., 2025). Because of these advantages, many governments across the world promote CNG transportation systems as part of sustainable urban transport policies.

In Nigeria, the adoption of CNG buses has gained policy attention as a strategy for mitigating the impact of rising fuel prices and improving affordable mobility for commuters. The Federal Government of Nigeria has introduced initiatives supporting the deployment of CNG vehicles to reduce transportation costs and promote energy diversification (Nairametrics, 2024). Within Kaduna State, the introduction of the CNG bus transport scheme under the Kaduna State Transport Service represents one of the state government's major policy interventions aimed at improving commuter mobility and reducing transportation costs for residents.

Public Service Delivery

Public service delivery refers to the provision of essential services by government institutions to meet the needs of citizens. These services include transportation, healthcare, education, infrastructure, and administrative services. Effective public service delivery requires efficiency, accessibility, responsiveness, and accountability within government institutions (Legas, 2024).

Transportation systems constitute an important component of public service delivery because they facilitate access to workplaces, schools, healthcare centres, and government offices. Scholars emphasize that transportation infrastructure forms the backbone of effective service delivery systems because citizens depend on mobility systems to access socio-economic opportunities and public institutions (World Bank, 2023). Efficient and affordable transportation systems improve productivity, reduce commuting stress, and enhance socio-economic welfare. Conversely, inefficient transport systems may undermine service delivery by causing delays, reducing workforce productivity, and limiting citizens' access to public services.

Within the context of this study, the CNG bus initiative introduced in Kaduna State represents a government transportation policy designed to improve urban mobility and strengthen public service accessibility.

Commuter Accessibility

Commuter accessibility refers to the ability of individuals to reach workplaces, schools, markets, healthcare facilities, and public institutions within reasonable time and cost constraints. Accessibility is widely regarded as one of the most important indicators of effective transportation systems because transport systems that provide reliable routes, affordable fares,

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and frequent services significantly improve urban productivity and socio-economic participation (Lucas, 2023).

Recent studies on urban mobility indicate that accessibility is strongly influenced by transport network coverage, service frequency, route connectivity, and travel costs (World Bank, 2023). In many developing urban environments, poor accessibility results from inadequate public transport fleets, inefficient route planning, and infrastructural deficiencies. Government-subsidized transport initiatives are commonly used to address accessibility challenges by reducing transportation costs and increasing mobility opportunities for low-income commuters. Evidence from Kaduna State indicates that the CNG bus initiative significantly improved accessibility for commuters by reducing transport costs and improving connectivity between residential communities and major employment centres. Reports indicate that over 1.4 million passengers utilized the buses within five months of operation, resulting in approximately ₦1.39 billion in transportation cost savings for residents (Maiyaki, 2025). These outcomes demonstrate the potential of subsidized transportation systems to improve commuter accessibility and support economic activities.

Service Timeliness in Public Transport

Service timeliness refers to the ability of transport services to operate according to scheduled departure and arrival times. Timeliness is one of the most important determinants of commuter satisfaction and public transport reliability because commuters rely on predictable schedules for planning their daily activities.

Studies on public transportation service quality indicate that delays, irregular schedules, and long waiting times are major factors discouraging commuters from using public transportation systems (Sogbe & Susilawati, 2024). For civil servants and students who depend heavily on public transportation systems, service timeliness is particularly important because delays may affect workplace punctuality and academic attendance. Research on bus transport reliability shows that commuters are more likely to depend on transportation systems that provide predictable schedules and reliable service frequency (Rashvand et al., 2023). Within the context of this study, service timeliness is examined as an important variable influencing the effectiveness of the CNG bus transport initiative in Kaduna State.

Empirical Review

Empirical studies on public transportation systems emphasize the important role of reliable and affordable mobility in enhancing urban productivity, social inclusion, and access to public services. In developing countries, bus transport systems remain one of the most widely used forms of public transportation because of their affordability and route flexibility.

Cui et al. (2023) examined the influence of bus service quality on commuter travel behaviour using an integrated modelling approach. The study found that reliability, accessibility, service frequency, and affordability significantly influence commuter decisions to use public buses. The study concluded that improving service reliability and route connectivity increases public transport usage and improves urban mobility. Similarly, El-Sayed and Ahmed (2025) investigated urban transport system efficiency using econometric modelling techniques. Their findings revealed that scheduling systems, maintenance planning, and real-time passenger information significantly improve operational efficiency and commuter satisfaction within urban transport systems.

Studies on sustainable transportation technologies have also examined the reliability of alternative energy buses. Niewczas et al. (2025) conducted a comparative reliability study of modern bus fleets and found that sustainable buses, including electric and alternative fuel buses, provide efficient urban mobility when supported by effective maintenance systems and operational management. Rashvand et al. (2023) further emphasized the importance of schedule reliability in public transportation systems. Their study on real-time bus arrival prediction revealed that discrepancies between scheduled and actual bus arrival times significantly reduce commuter confidence in public transportation systems and negatively affect commuter planning. Within Africa, studies on urban transportation reforms indicate that subsidized transport programs significantly reduce transportation costs and improve access to employment and educational opportunities. However, these programs frequently experience challenges associated with inadequate fleet capacity, overcrowding, and inconsistent scheduling systems (Sogbe & Susilawati, 2024).

In Nigeria, studies on urban transportation have primarily focused on traffic congestion, infrastructure deficits, and public transport reforms. Adeniyi and Ojo (2023) observed that rising transportation costs and inadequate transport systems negatively affect urban productivity and workforce mobility in Nigerian cities. However, few studies have specifically examined how

government-supported CNG transport systems influence commuter accessibility and public service delivery outcomes. Despite growing literature on sustainable urban transportation, there remains limited empirical research examining the effectiveness of CNG bus transport initiatives in improving commuter accessibility and public service delivery within Nigerian urban environments. Most existing studies focus primarily on environmental sustainability and fuel efficiency rather than commuter experiences and operational effectiveness.

This study therefore fills this gap by examining the operational effectiveness of the CNG bus transport system introduced in Kaduna State and assessing its impact on commuter accessibility, service timeliness, and public service delivery outcomes.

Theoretical Framework

Public Service Delivery Theory

This study is anchored on Public Service Delivery Theory, which emphasizes efficiency, accessibility, responsiveness, and accountability in the provision of public services. The theory explains how government institutions provide essential services to citizens through policy implementation and administrative systems (Legas, 2024).

Public Service Delivery Theory argues that effective service delivery occurs when public institutions provide services in ways that are timely, accessible, affordable, and responsive to citizens’ needs. Transportation systems are regarded as important components of public service delivery because they facilitate access to workplaces, schools, healthcare facilities, and government institutions. Scholars argue that efficient transportation systems improve socio-economic productivity, enhance labour mobility, and strengthen administrative effectiveness (World Bank, 2023). Conversely, inefficient transportation systems may undermine workforce productivity and reduce citizens’ access to public services. Within the context of this study, the CNG bus transport initiative introduced by the government of Kaduna State represents a public service intervention designed to improve urban mobility and enhance commuter accessibility.

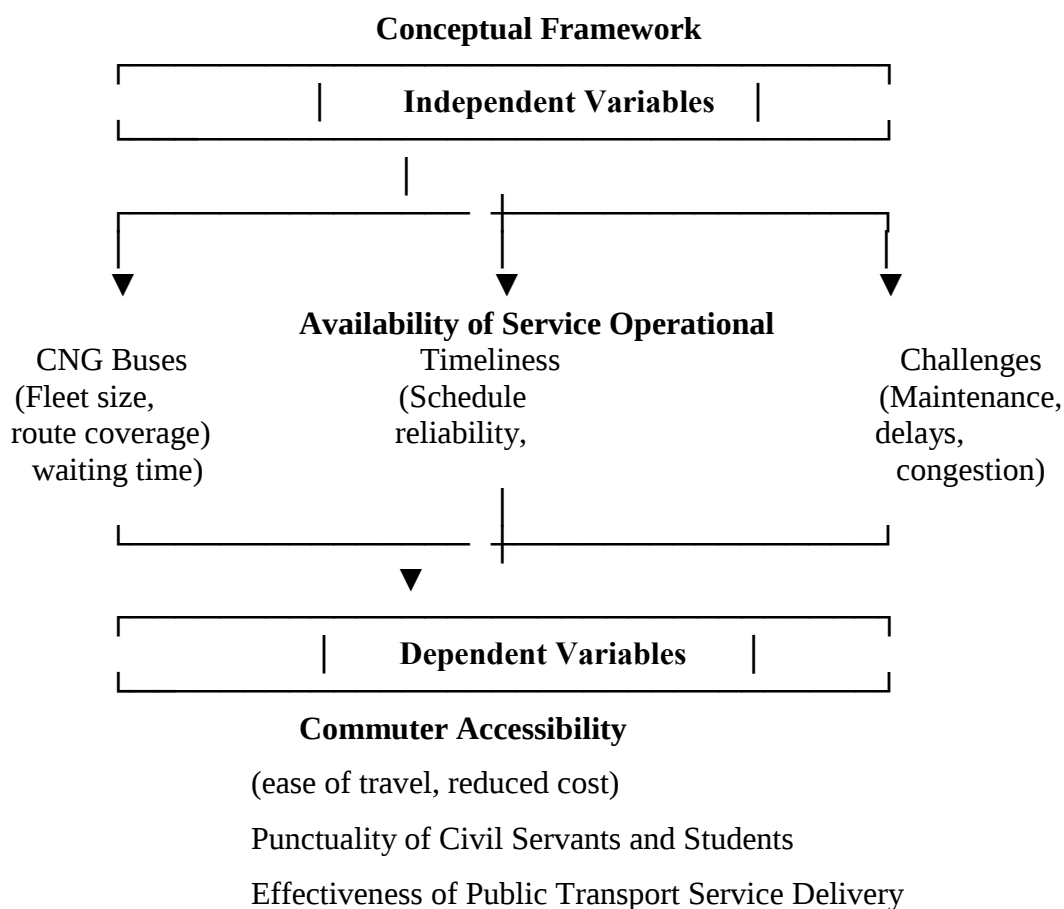
Theoretical Propositions for the Study

The theory is linked to the study variables in the following ways:

Theoretical Element	Study Variable	Expected Outcome
Accessibility	Availability of CNG buses	Improved commuter mobility
Efficiency	Service timeliness	Increased commuter

		punctuality
Responsiveness	Operational management	Improved commuter satisfaction
Service Delivery	Transport effectiveness	Enhanced urban accessibility

The theory therefore provides an appropriate framework for understanding how transportation policy interventions influence commuter experiences and public service delivery outcomes within urban governance systems.



Methodology

Research Design

The study adopted a mixed-method research design combining qualitative and descriptive survey approaches. The qualitative component enabled an in-depth understanding of commuter experiences and operational challenges associated with the Compressed Natural Gas (CNG) bus transport system, while the descriptive survey component provided measurable data regarding commuter perceptions and transport service effectiveness (Creswell, 2018).

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The mixed-method approach was considered appropriate because it allowed the researcher to combine numerical data with qualitative explanations in order to achieve a broader understanding of the effectiveness of the CNG transport initiative in Kaduna State.

Area of the Study

The study was conducted in selected commuter corridors within Kaduna metropolis, specifically Rigachikun, Rido, and Tudun Wada wards. These areas were selected because they represent major commuter routes served by the Kaduna State Transport Service CNG buses. The selected routes connect residential communities with employment centres, educational institutions, markets, and government offices, making them suitable locations for examining commuter accessibility and transport service delivery.

Population of the Study

The population of the study consisted of civil servants, students, market commuters, and transport officials who regularly utilize the CNG bus services within the selected wards.

The population distribution is presented below:

Ward/Commuter Category	Civil Servants	Students	Market Commuters	Transport Officials	Total Population
Rigachikun	1200	800	600	2	2602
Rido	1000	1000	700	2	2702
Tudun Wada	1100	900	800	2	2802
Total	3300	2700	2100	6	8106

Source: Researcher Survey, 2026.

Sampling Technique and Sample Size

Purposive sampling was adopted to select respondents who regularly use the CNG bus transport system across the selected commuter corridors. The technique was considered appropriate because the study specifically targeted respondents with direct experience and knowledge of the transport system, including civil servants, students, market commuters, and transport officials.

Purposive sampling is widely used in qualitative and policy-oriented research where respondents are selected based on their relevance to the research objectives. A total of 120 questionnaires were distributed across the three selected wards as follows:

Wards	Questionnaires Distributed
Rigachikun	40
Rido	40
Tudun Wada	40
Total	120

Source: Researcher Survey, 2026

Methods of Data Collection

Data for the study were collected through the following methods:

Questionnaires

Structured questionnaires were administered to commuters across the selected wards in order to obtain data regarding commuter accessibility, service timeliness, and operational challenges affecting the CNG transport system.

Semi-Structured Interviews

Semi-structured interviews were conducted with selected civil servants, students, and transport officials to obtain detailed qualitative information regarding commuter experiences and operational effectiveness.

Field Observation

The researcher conducted direct observations at selected bus terminals and commuter points in order to assess passenger congestion, waiting times, and bus availability during peak periods.

Validity and Reliability of Research Instruments

To ensure validity, the questionnaire and interview guide were designed in line with the objectives of the study and the major research variables. Experts in public administration and transportation studies reviewed the instruments to ensure content validity.

Reliability was enhanced through pre-testing of the questionnaire among selected commuters outside the sampled wards. Ambiguous questions were corrected before final administration of the instruments.

Ethical Considerations

The study adhered to ethical research principles throughout the research process. Participation was voluntary, and respondents were informed about the purpose of the study before data collection. Confidentiality and anonymity of respondents were maintained, and respondents were assured that information obtained would be used strictly for academic purposes.

Methods of Data Analysis

The study utilized both qualitative and quantitative methods of data analysis.

Thematic Analysis

Thematic analysis was used to analyze qualitative responses obtained from interviews and field observations. Responses were grouped into themes based on recurring patterns and issues relating to commuter accessibility, service timeliness, and operational challenges.

Descriptive Statistics

Descriptive statistical tools such as frequency tables and percentages were used to analyze quantitative data obtained through questionnaires.

The combination of thematic analysis and descriptive statistics enabled the study to provide both numerical and explanatory interpretations of the effectiveness of the CNG transport system.

Data Presentation and Analysis

This section presents and analyzes data collected from respondents across the selected wards: Rigachikun, Rido, and Tudun Wada. The analysis focuses on the major variables identified in the conceptual framework, namely availability of CNG buses, service timeliness, operational challenges, commuter accessibility, and effectiveness of public transport service delivery.

The themes generated from the data were organized in line with the objectives of the study.

Ward-Level Response Distribution

Wards	Questionnaires Distributed	Returned	Valid Responses
Rigachikun	40	38	36
Rido	40	37	35
Tudun Wada	40	36	34
Total	120	111	105

Source: Researcher Survey, 2026.

The response rate of 87.5% indicates a strong level of participation among respondents across the selected wards.

Theme 1: Availability of CNG Buses and Commuter Accessibility

This theme examines how the availability of CNG buses influences commuter mobility and accessibility to workplaces, schools, and markets.

Response Category	Frequency	Percentage
Highly Improved Accessibility	42	40%
Moderately Improved Accessibility	38	36%
Slight Improvement	15	14%
No Improvement	10	10%
Total	105	100%

Source: Researcher Survey, 2026.

The findings indicate that the majority of respondents (76%) reported that the introduction of the CNG bus transport system significantly improved accessibility to workplaces, schools, and markets. Respondents noted that the buses reduced transportation costs and improved connectivity between residential communities and employment centres.

A civil servant in Rigachikun stated: “The buses have reduced our transport expenses significantly and made it easier to get to work every day. “However, some respondents indicated that limited fleet capacity during peak periods reduced the effectiveness of the system despite the affordability of the transport service.

Theme 2: Service Timeliness and Commuter Punctuality

This theme examines how bus schedules and service reliability influence punctuality among commuters, particularly civil servants and students.

Response Category	Frequency	Percentage
Very Reliable	20	19%
Moderately Reliable	35	33%
Occasionally Delayed	32	30%
Frequently Delayed	18	17%
Total	105	100%

Source: Researcher Survey, 2026.

The findings reveal that while some respondents considered the transport service reliable, approximately 47% reported that buses were either occasionally or frequently delayed. Delays were more common during morning and evening peak periods when commuter demand was high.

A student respondent from Tudun Wada stated: “The buses help students save money, but delays sometimes make us miss early lectures.” Similarly, civil servants in Rido ward emphasized that

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irregular schedules occasionally affected punctuality at workplaces. It's observed that irregular bus arrival times reduce commuter confidence and negatively affect travel planning.

Theme 3: Operational Challenges Affecting the Transport System

This theme identifies operational challenges affecting the effectiveness of the CNG bus transport system.

Operational Challenge	Frequency	Percentage
Limited Number of Buses	43	41%
Long Waiting Time	30	29%
Maintenance Issues	18	17%
Traffic Congestion	14	13%
Total	105	100%

Source: Researcher Survey, 2026.

The most frequently identified operational challenge was inadequate fleet capacity, accounting for 41% of responses. Respondents indicated that the number of buses available was insufficient to meet commuter demand during peak periods.

Long waiting times were also commonly reported, particularly along the Rigachikun and Rido routes. Respondents further identified maintenance issues and traffic congestion as factors affecting service reliability and operational efficiency. Based on these findings its observed that inadequate service frequency and operational inefficiencies reduce commuter satisfaction within urban transportation systems.

Discussion of Findings

The findings of this study demonstrate that the introduction of the Compressed Natural Gas (CNG) bus initiative in Kaduna State has significantly improved commuter accessibility and reduced transportation costs for many urban residents. The majority of respondents reported that the subsidized transport system enhanced mobility between residential communities, workplaces, schools, and markets. Based on this findings it's observed that affordable transportation systems improve urban accessibility and socio-economic participation.

The study further revealed that the CNG bus initiative contributed positively to public service delivery by enabling civil servants and students to access workplaces and educational institutions more conveniently. The affordability of the buses reduced the financial burden associated with transportation following the removal of fuel subsidies in Nigeria. Based on this finding its

observed that efficient public transportation systems improve workforce productivity and socio-economic welfare. Despite these positive outcomes, the study identified several operational challenges limiting the effectiveness of the transport system. Respondents reported that delays, overcrowding, irregular schedules, and inadequate fleet capacity reduced service reliability, particularly during peak commuting hours. These operational inefficiencies affected commuter punctuality and overall satisfaction with the transport system.

Based on these findings, it's observed that inconsistencies between scheduled and actual bus arrival times significantly affect commuter confidence and disrupt travel planning. Similarly, inadequate service frequency and unreliable schedules reduce the effectiveness of public transportation systems in developing urban environments.

The study also found that limited fleet size was the most significant operational challenge affecting the CNG transport system. Many respondents indicated that available buses were insufficient to accommodate increasing commuter demand during peak periods. This finding aligns with studies on urban transport reforms in developing countries, which suggest that subsidized transportation programmes often experience operational constraints associated with inadequate fleet capacity and overcrowding.

Furthermore, the findings support Public Service Delivery Theory, which emphasizes accessibility, efficiency, responsiveness, and accountability in the provision of public services. The study shows that while the Kaduna State CNG initiative improved urban mobility and commuter accessibility, operational efficiency remains critical for achieving effective public service delivery outcomes.

Summary of Major Findings

The study revealed the following major findings:

- i. The introduction of the CNG bus transport system significantly improved commuter accessibility by reducing transportation costs and improving connectivity between residential communities and major employment centres.
- ii. The majority of respondents reported that the transport initiative enhanced access to workplaces, schools, and markets, thereby improving urban mobility. While, service timeliness remains a major operational challenge affecting commuter punctuality, especially during peak commuting periods.

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- iii. Delays, overcrowding, and irregular bus schedules negatively affect commuter satisfaction and transport reliability. Inadequate fleet capacity was identified as the most significant operational challenge limiting the effectiveness of the transport system.
- iv. The CNG bus initiative contributes positively to public service delivery by improving mobility for civil servants, students, and low-income commuters. Operational efficiency is essential for sustaining the effectiveness of government-supported transportation systems.

Conclusion

The study examined the effectiveness of the Compressed Natural Gas (CNG) bus transport initiative introduced by the government of Kaduna State in improving commuter accessibility and public service delivery within selected commuter corridors.

The findings revealed that the CNG transport initiative significantly improved urban mobility and reduced transportation costs for commuters, particularly civil servants, students, and low-income earners. The subsidized nature of the transport system enhanced commuter accessibility and strengthened connectivity between residential communities, workplaces, educational institutions, and markets.

The study further established that transportation systems play an important role in public service delivery because they facilitate access to socio-economic opportunities and government institutions. The CNG bus initiative therefore represents an important policy intervention aimed at improving urban mobility and mitigating the socio-economic effects of rising transportation costs in Nigeria. However, the study also revealed that operational challenges including inadequate fleet capacity, delays, overcrowding, irregular schedules, and maintenance issues continue to reduce the effectiveness and reliability of the transport system. These operational inefficiencies negatively affect commuter punctuality and satisfaction, particularly during peak periods.

The study therefore concludes that while the CNG transport initiative has achieved significant progress in improving affordability and commuter mobility, sustainable urban transport service delivery requires efficient operational management systems capable of ensuring reliability, timeliness, and commuter satisfaction. The study further highlights the broader importance of transportation policy interventions in promoting urban governance, workforce productivity, and inclusive socio-economic development within Nigerian cities.

Recommendations

Based on the findings of the study, the following recommendations are made:

- i. The government of Kaduna State should increase the number of CNG buses operating on high-demand commuter routes in order to reduce overcrowding and long waiting times.
- ii. The Kaduna State Transport Service should introduce digital timetable and real-time bus tracking systems to improve service reliability and commuter, strengthen maintenance and operational management systems to improve bus reliability and reduce service interruptions.
- iii. Additional commuter corridors and urban communities should be incorporated into the CNG transport network in order to improve accessibility across more areas within Kaduna metropolis. Periodic monitoring and commuter satisfaction assessments should be conducted to evaluate service quality and improve transport policy implementation.
- iv. Public-private partnerships should be encouraged to support long-term sustainability and expansion of urban transportation infrastructure. Traffic management systems should be improved within major commuter corridors to reduce congestion and enhance operational efficiency.

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