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SUSTAINABLE TRANSPORTATION MANAGEMENT IN DEVELOPING COUNTRIES: CHALLENGES AND INNOVATION-A FOCUS ON NIGERIA

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Abstract

This study examines sustainable transportation management in Nigeria, focusing on key challenges and emerging innovations. Employing a qualitative-dominant mixed-methods approach including interviews, focus group discussions, and document analysis the study investigates institutional, infrastructural, and technological factors shaping transport systems. Findings reveal persistent challenges such as institutional fragmentation, inadequate infrastructure, and limited technological adoption, alongside promising innovations including electric vehicle initiatives and community-based transport models. Data were analyzed thematically and interpreted using the Avoid–Shift–Improve (ASI) framework to identify dominant patterns in governance, infrastructure provision, technological adoption, and community participation. The results indicate that weak intergovernmental coordination, inadequate financing, and limited technological capacity remain major constraints to sustainable transport delivery. Nevertheless, stakeholder responses highlight that improved policy harmonization across federal and state levels, investments in bus rapid transit systems, renewable-energy-supported charging infrastructure, and participatory transport planning can enhance public transport uptake and project acceptance. The study further underscores the role of non-motorized transport and locally anchored innovation in addressing Nigeria's rapidly growing motorization rate. The paper concludes by recommending strengthened institutional coordination, mobilization of green financing mechanisms, support for local electric vehicle manufacturing, and mainstreaming sustainable transportation within national development planning. These interventions align with Sustainable Development Goals 9 and 11 and provide policy lessons relevant for other sub-Saharan African countries facing similar urban mobility challenges.

Key words: *sustainable transport, electric vehicles, social inclusion*

1.1 Introduction

Transportation is universally acknowledged as essential for any meaningful development. Efficient transport systems facilitate the movement of people, goods, and services, thereby stimulating trade, enhancing access to markets, improving quality of life, and fostering national integration (Rodrigue, 2020). Over the past two decades, the concept of sustainable transportation has gained prominence in global development discourse. Defined as mobility that meets current transport and environmental needs without compromising the capacity of future generations, sustainable transportation emphasizes affordability, accessibility, safety, and ecological balance (Banister, 2008; Litman, 2022). Sustainable transportation is central to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities), which call for the development of resilient infrastructure and inclusive, safe, and sustainable urban transport systems (United Nations, 2015). In advanced economies, governments have integrated low-carbon mobility, non-motorized transport (NMT), electrification, and intelligent transport systems (ITS) into national development strategies to reduce emissions, decongest urban centres, and promote inclusive mobility (Schiller, Bruun, & Kenworthy, 2010; ITF, 2021).

Sustainable transportation is critical to economic productivity, environmental protection, and social inclusion. In Nigeria, however, only 18% of federal roads are in good condition, and electric vehicles (EVs) contribute less than 1% of total registered vehicles, highlighting significant infrastructural and technological deficits. This study investigates the challenges and innovations shaping sustainable transportation in Nigeria using a qualitative-dominant mixed-methods approach. Data were collected from 87 stakeholders, including federal and state transport ministries (25%), private sector operators (35%), urban planners (20%), and civil society groups (20%), through 45 semi-structured interviews, six focus group discussions, and content analysis of 32 national and subnational transport-related policies, strategies, and planning documents (2010–2023). Additional insights were drawn from World Bank and national transport reports. Findings indicate that harmonizing transport policies across federal and state levels can substantially reduce implementation delays. Analysis further indicates that solar-powered charging infrastructure and bus rapid transit (BRT) systems are associated with notable increases in public transport adoption. Additionally, community engagement in transport planning enhances project acceptance and reduces resistance, with participatory (consultative) models proving more effective than top-down approaches. The study recommends efforts geared toward strengthening

and harmonizing the legal and institutional framework, mobilizing green finance instruments, building local electric vehicle manufacturing capacity, scaling up non-motorized transport networks, and mainstreaming sustainable transportation in national development planning. These policy interventions align with Sustainable Development Goals (SDGs) 9 and 11 and offer scalable models for other sub-Saharan African countries facing rapid motorization, currently growing at an estimated 8% annually.

However, achieving sustainable transportation in developing countries, particularly in sub-Saharan Africa, remains a formidable challenge. Nigeria, Africa's most populous country, has one of the largest and most complex urban transport systems on the continent, marked by inefficiencies, high environmental costs, and deep social inequities (Aderamo & Magaji, 2010; Olukoju, 2021). The rapid rate of urbanization, estimated at 4.2% annually, has overwhelmed existing infrastructure, leading to chronic congestion, road safety issues, and poor public transport services (UN-Habitat, 2022; AfDB, 2019). Moreover, Nigeria's transport sector contributes significantly to greenhouse gas emissions and air pollution, especially in cities like Lagos and Abuja (World Bank, 2020). Although Nigeria has articulated several policy responses, such as the National Transport Policy (2017) and its Nationally Determined Contributions (NDCs) under the Paris Climate Agreement, implementation has been weak, and policy coherence remains a challenge (Federal Ministry of Transportation, 2017; NDC Partnership, 2021). Public institutions suffer from overlapping mandates, underfunding, and limited capacity to scale innovative solutions. Consequently, the transition to sustainable mobility is constrained by outdated legal frameworks, inadequate stakeholder coordination, and a lack of investment in green and resilient infrastructure (Akinmoladun & Oluwoye, 2007; Oyesiku & Gbadamosi, 2012).

In light of these constraints, there is growing recognition of the need for innovative and inclusive approaches to transport management. Emerging interventions such as smart mobility solutions, electric vehicle (EV) pilots, non-motorized transport infrastructure, and community-based transport models offer promising pathways for transformation (Agyapong & Kwadwo, 2021; ITDP, 2019). At the same time, digital technologies ranging from real-time traffic data analytics to mobile ride-sharing platforms have the potential to reduce inefficiencies and increase system responsiveness, especially in underserved urban and peri-urban areas.

Against this background, this paper seeks to critically explore the challenges facing sustainable transportation management in Nigeria and to highlight the innovative practices being adopted in response. Specifically, the objectives of this study are:

1. To identify and analyse the major infrastructural, institutional, and policy challenges impeding sustainable transportation in Nigeria;
2. To examine emerging innovative strategies that address these challenges;
3. To propose policy recommendations aimed at aligning Nigeria's transport systems with international sustainability commitments, especially the SDGs.

By drawing on national case studies, policy documents, and cross-national insights, the paper contributes to the body of knowledge on sustainable urban mobility in developing countries. It emphasizes the importance of governance frameworks, institutional synergy, digital transformation, and inclusive planning in achieving a more resilient and equitable transportation future for Nigeria.

1.2 Scope of the Study

This study examines sustainable transportation management in developing countries, with a specific focus on Nigeria. It investigates key challenges and innovative strategies within urban transport systems, using Lagos, Abuja, and Kano as focus cities due to their strategic importance and varied transport experiences. The scope is limited to road-based urban transportation and targets stakeholders such as government agencies, transport operators, civil society organizations, and urban commuters. The study covers developments between 2010 and 2024, emphasizing recent trends, policies, and innovations such as smart mobility, non-motorized transport, and e-governance tools.

2.0 Literature Review

2.1 Concept of Sustainable Transportation

The concept of sustainable transportation has evolved as a critical dimension of sustainable development discourse, particularly in response to the adverse impacts of conventional transportation systems on the environment, social equity, and economic viability. Originating in the late 1980s and early 1990s alongside global environmental movements and the publication of the Brundtland Report (WCED, 1987), the notion of sustainability in transport gained formal recognition during the United Nations Conference on Environment and Development (UNCED) in 1992. The report underscored the

need for development that meets present needs without compromising future generations, a principle that strongly applies to mobility systems.

While definitions vary slightly across literature, there is consensus on the foundational elements of sustainable transportation. The OECD (1996) defined sustainable transport as "transport that does not endanger public health or ecosystems and meets mobility needs consistent with the use of renewable resources." Similarly, the European Conference of Ministers of Transport (ECMT, 2004) elaborated that sustainable transport should be accessible, safe, environmentally friendly, and economically viable.

A more widely cited academic definition comes from Banister (2008), who describes sustainable mobility as transport systems that reduce the need to travel, encourage modal shift to sustainable modes, and reduce the environmental impact of transport. He emphasizes behavioral change, land-use integration, and technological innovation as core strategies. According to Litman (2022), sustainable transportation maximizes accessibility while minimizing social and ecological costs, including congestion, air pollution, road fatalities, and land degradation.

2.1.1 Key Attributes and Components of Sustainable Transportation

Sustainable transportation systems are characterized by several interrelated attributes. Schiller, Bruun, and Kenworthy (2010) identify three pillars environmental sustainability, social equity, and economic efficiency as guiding principles:

Environmental sustainability: This involves reducing greenhouse gas (GHG) emissions, improving fuel efficiency, protecting ecosystems, and promoting low-emission modes such as walking, cycling, and electric vehicles.

Social inclusiveness: Sustainable systems ensure equitable access to transport services, particularly for vulnerable groups such as the poor, elderly, women, and persons with disabilities (Lucas, 2012).

Economic viability: Efficient transportation supports economic activities by minimizing travel time, reducing energy use, and lowering infrastructure maintenance costs (World Bank, 2018).

In operational terms, sustainable transportation comprises various modes and practices including:

- Non-motorized transport (NMT) such as walking and cycling;
- Public mass transit systems like Bus Rapid Transit (BRT) and light rail;

- Smart mobility solutions (e.g., Intelligent Transport Systems and Mobility-as-a-Service platforms);
- Clean energy vehicles, including electric buses and cars;
- Transit-oriented development (TOD) and mixed land-use planning.

These components contribute to mobility systems that are resilient, energy-efficient, and adaptable to climate change (ITDP, 2019).

2.1.2 Evolution and Current Debates

The evolution of sustainable transport thought has moved from a focus on environmental sustainability to a broader paradigm that includes social justice and spatial equity. Scholars such as Lucas (2012) and Martens (2016) argue that access to transport is a human right and that transport planning should be oriented around equity and inclusion rather than just efficiency and environmental performance. In response, the Transport Justice literature advocates for mobility systems that prioritize disadvantaged populations and underserved regions.

On the global policy front, the United Nations' Sustainable Development Goals (SDGs) specifically Goal 11.2 call for "access to safe, affordable, accessible and sustainable transport systems for all by 2030." This has spurred renewed investment and reforms in urban transport, particularly in developing countries where informal transport systems dominate (UN-Habitat, 2022).

Technological advancements have increasingly shaped the discourse on sustainable transportation. Digital platforms, ride-sharing services, and integrated ticketing systems are recognized as tools for improving service delivery, reducing operational costs, and enhancing commuter experiences. However, scholars caution against **"technosolutionism"**, which refers to an overreliance on technological solutions to address complex societal challenges (Gössling, 2020). In the context of urban mobility in Nigeria, technosolutionism manifests through the adoption of mobile ticketing, smart transport apps, and data-driven infrastructure aimed at improving transport efficiency and reducing congestion. While these innovations offer tangible benefits, they cannot fully address the underlying institutional, infrastructural, and social factors that drive unsustainable transport systems.

Furthermore, climate change is reshaping global transport policies. The Intergovernmental Panel on Climate Change (IPCC, 2022) notes that the transport sector accounts for nearly 25% of global CO_2

emissions, with most growth occurring in developing countries. This has led to growing advocacy for climate-resilient infrastructure, electrification, and low-carbon mobility models.

In Africa, sustainable transport has gained momentum through initiatives like Africa Sustainable Transport Forum and AfDB's Urban Mobility Program, though implementation lags due to financing, policy fragmentation, and limited local capacity (AfDB, 2019; UNEP, 2016).

In summary, the concept of sustainable transportation has matured into a multidimensional framework grounded in environmental integrity, social justice, and economic resilience. While global thought leadership continues to shape the field, its successful application particularly in developing countries depends on context-specific strategies, strong institutional frameworks, and inclusive policy-making. As Nigeria and other African nations attempt to align with global sustainability targets, understanding these core principles is critical to designing actionable and transformative transport policies.

2.2 Policy and Governance Challenges

A critical challenge to sustainable transportation in Nigeria lies in the persistent gap between policy formulation and effective implementation. While the National Transport Policy (2010) articulates ambitious objectives such as intermodal connectivity, low-carbon mobility, and integrated planning its practical impact has been limited by institutional fragmentation, bureaucratic inertia, and inadequate enforcement mechanisms (Akinmoladun & Oluwoye, 2019).

Nigeria's transport governance structure is characterized by fragmented responsibilities among federal, state, and local authorities, often resulting in overlapping mandates and poor coordination. For example, the Federal Ministry of Transportation, state ministries, metropolitan transport agencies, and parastatals like the Nigeria Railway Corporation frequently operate in silos. This institutional disconnect impedes efficiency, undermines strategic coherence, and delays project execution (Federal Ministry of Transportation, 2017).

Governance weaknesses, including inconsistent policy continuity, corruption in procurement, and weak regulatory oversight, further constrain progress. Many transport initiatives experience cost overruns, delays, or abandonment due to lack of transparency and political interference (Ogunsanya, 2020).

Additionally, transport planning in Nigeria remains heavily road-centric, with limited attention to rail, inland waterways, or non-motorized transport (NMT). This imbalance perpetuates high levels of

greenhouse gas emissions and excludes low-income populations who depend on more accessible and affordable modes (Oyesiku & Gbadamosi, 2012).

The absence of a unified national urban mobility strategy has also hindered integration between transport, land use, and environmental policy. Without a robust legal and institutional framework that supports coherence, stakeholder collaboration, and results-based implementation, the transformative potential of Nigeria's transport sector remains largely untapped (UN-Habitat, 2022).

2.3 Infrastructure and Financing Gaps

Infrastructure remains the backbone of an effective and sustainable transportation system. In Nigeria, however, the current state of transport infrastructure is characterized by aging road networks, underdeveloped rail systems, dilapidated urban transit terminals, and limited intermodal connectivity. According to the African Development Bank (AfDB, 2022), Nigeria requires more than $100 billion in infrastructure investments over the next decade to address mounting urban mobility needs and regional connectivity challenges. This figure underscores the magnitude of deficits in transport infrastructure across cities like Lagos, Abuja, Kano, and Port Harcourt, where rapid urbanization has outpaced infrastructural growth.

The financing gap is largely a product of multiple interlinked factors. One is the persistent budgetary constraints at both federal and state levels. Nigeria typically allocates less than 5% of its annual budget to the transportation sector, a figure far below global benchmarks for emerging economies (World Bank, 2020). This underfunding is compounded by a poor maintenance culture, where investments made in roads, bus terminals, and bridges quickly deteriorate due to lack of regular upkeep and oversight (Olaseni & Alade, 2012). Moreover, the absence of innovative financing mechanisms such as land value capture, road user charges, or infrastructure bonds limits the ability of authorities to attract long-term, private sector-driven investments. Bureaucratic bottlenecks, policy inconsistencies, and low creditworthiness of government transport agencies also deter both domestic and international investors from committing to large-scale infrastructure projects (Eberhard et al., 2021).

The result is a cycle where demand for transport services continues to rise, while supply remains inadequate and inefficient. This situation not only hampers mobility and productivity but also exacerbates congestion, pollution, and road safety risks, all of which undermine the goals of sustainable urban transportation.

2.4 Theoretical Framework: Avoid-Shift-Improve (ASI) Framework (2002)

The Avoid-Shift-Improve (ASI) framework, formally promoted by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) around 2002, serves as a widely adopted conceptual model for advancing sustainable transportation, particularly in developing countries. Developed in collaboration with international partners such as the Asian Development Bank (ADB), UNEP, and SLoCaT, the ASI framework has been used in various policy and academic contexts to guide transport planning and climate mitigation efforts (Sakamoto, Dalkmann & Palmer, 2010; Bongardt et al., 2019). It is based on the assumption that a sustainable transport system can be achieved through integrated strategies that reduce the need for travel, promote modal shift, and improve system efficiency.

The model comprises three pillars. Avoid focuses on reducing unnecessary travel and trip lengths through integrated land-use planning, telecommuting, and digital alternatives such as e-governance platforms, assuming travel behavior can be influenced through spatial and digital interventions. Shift encourages the use of sustainable transport modes like public transit, cycling, and walking by assuming that availability and reliability of alternatives can alter user preferences. Improve emphasizes technological upgrades such as intelligent transport systems (ITS), fuel-efficient vehicles, and cleaner energy, assuming that innovation is central to long-term sustainability. Together, these strategies offer a scalable and holistic approach for reducing emissions and promoting equitable mobility (GIZ, 2016).

While the ASI model is practical and flexible, it has attracted critiques. Scholars argue it may oversimplify urban transport complexities in low-income settings by overlooking political, institutional, and cultural barriers (Lucas, 2012; Martens, 2016). Its technological bias under "Improve" may draw attention away from governance reforms and social innovation (Gössling, 2020). Further, implementation gaps due to poor coordination, weak policy enforcement, and inadequate financing remain prevalent across many Global South contexts, including Nigeria (UN-Habitat, 2022). Moreover, critics highlight its limited attention to equity and transport justice, particularly regarding the mobility needs of marginalized populations (Martens, 2016). Despite these limitations, the ASI model remains valuable, especially when applied contextually with participatory and inclusive strategies.

In this study, the ASI framework is applied to examine sustainable transportation management in Nigeria by categorizing the country's transport challenges and innovation efforts. For instance, land-use inefficiencies and lack of digital service infrastructure relate to the 'Avoid' pillar; the dominance

of informal transport and weak public transit systems point to 'Shift' challenges; and efforts around BRT systems, ITS, and electric vehicles reflect 'Improve' initiatives. The framework also supports analysis of Nigeria's alignment with the Sustainable Development Goals (SDGs) especially Goal 11 (Sustainable Cities and Communities) and Goal 13 (Climate Action) and provides a basis for evaluating governance reforms, institutional integration, and policy innovations required for a more sustainable transport future. As such, the ASI model offers both a diagnostic and prescriptive tool for this research, aligning global theory with Nigeria's practical realities.

3.0 Methodology

3.1 Research Design

This study adopts a qualitative-dominant mixed-methods research design, integrating semi-structured interviews, focus group discussions (FGDs), and systematic document analysis, supported by descriptive statistics. The qualitative components were prioritized to generate in-depth insights into institutional, infrastructural, and technological dimensions of sustainable transportation management in Nigeria, while descriptive statistics were employed to contextualize dominant patterns emerging from stakeholder responses. The triangulation of multiple data sources enhanced the credibility, validity, and analytical depth of the findings

3.2 Data Sources and Sampling

A purposive sampling technique was employed to select participants with direct involvement or expertise in transport policy formulation, implementation, operation, and advocacy. A total of 87 stakeholders participated in the study, distributed as follows:

- Federal and state transport ministries – 25%
- Private transport operators and mobility technology firms – 35%
- Urban and regional planners – 20%
- Civil society organizations and transport advocacy groups – 20%

Primary data were generated through **20 semi-structured interviews** conducted with policymakers, regulatory agency officials, and private sector transport operators, complemented by **six focus group discussions (FGDs)** involving community transport users, urban planners, and civil society

representatives. In addition, **a systematic content analysis of 32 policy and planning documents** including national transport policies, sectoral strategies, and urban development plans published between **2010 and 2024** was undertaken to examine policy coherence, implementation priorities, and the integration of sustainability and innovation principles within Nigeria's transport governance framework.

Secondary data sources included reports and datasets from the World Bank, UN-Habitat, African Development Bank, National Bureau of Statistics (NBS), and institutional publications from the National Automotive Design and Development Council (NADDC), Lagos Metropolitan Area Transport Authority (LAMATA), and the Federal Ministry of Transportation. These sources provided contextual evidence on infrastructure conditions, motorization trends, and innovation initiatives

3.3 Data Collection Instruments

Semi-structured interview and FGD guides were developed in alignment with the Avoid–Shift–Improve (ASI) framework and relevant Sustainable Development Goal (SDG) transport targets, particularly SDGs 9 and 11. The instruments explored themes related to institutional coordination, transport equity and accessibility, innovation adoption, infrastructure financing, and stakeholder participation. The document review protocol focused on assessing policy coherence, implementation gaps, intergovernmental alignment, and the extent to which sustainability and innovation principles were mainstreamed in national and subnational transport plans.

3.4 Data Analysis

Qualitative data from interviews and FGDs were transcribed and analyzed using thematic analysis. An initial inductive coding process was conducted to identify recurring concepts and issues, which were subsequently organized into broader thematic categories consistent with the ASI framework. To enhance analytical clarity**, frequency counts were applied to coded themes, and indicative percentages were calculated to reflect the proportion of participants expressing similar views**. These percentages serve a **descriptive purpose**, illustrating dominant patterns within the dataset, and do **not imply statistical generalization or representativeness beyond the study sample**. Documentary evidence was analyzed through qualitative content analysis and integrated with primary data to triangulate findings, providing a robust basis for interpretation and discussion.

4.0 Challenges of Sustainable Transportation in Nigeria

4.1 Poor Infrastructure Quality: Nigeria's transportation infrastructure, particularly the road network, suffers from chronic underinvestment and poor maintenance. According to the Federal Ministry of Works and Housing (2022), more than 60% of roads are in poor condition, resulting in reduced accessibility, longer travel times, and elevated vehicle operating costs. The rail system, once a critical component of Nigeria's intercity transport, has been largely neglected, while inland waterways remain underutilized due to safety and navigational challenges (Akinyemi & Igbokwe, 2020). This disproportionate reliance on road transport has led to increased traffic congestion, accelerated road degradation, and a higher incidence of road accidents.

4.2 Rapid Urbanization and Congestion: Nigeria's urban population is growing at an annual rate of over 4%, putting immense pressure on already overburdened transport systems (UN-Habitat, 2022). Lagos, home to over 20 million people, experiences chronic traffic congestion, with estimated economic losses running into billions of naira daily due to lost productivity and increased fuel consumption (Aderibigbe, 2021). The dominance of informal transport operators such as minibuses (danfo) and tricycles (keke) exacerbates the problem, as these systems often lack regulation, operate without safety compliance, and contribute significantly to environmental pollution.

4.3 Weak Institutional Frameworks: The governance of Nigeria's transport sector is hampered by fragmented institutional arrangements and overlapping mandates. Agencies such as the Federal Road Safety Corps (FRSC), Nigeria Railway Corporation (NRC), and Lagos Metropolitan Area Transport Authority (LAMATA) frequently operate in silos, leading to poor coordination and policy inconsistency (Oni & Okanlawon, 2015). Moreover, the absence of integrated urban transport planning that links transport with housing, land use, and environmental management results in disjointed interventions that fail to address the systemic nature of urban mobility challenges.

4.4 Limited Adoption of Technology: Technological integration in Nigeria's transport sector remains minimal, particularly in the area of Intelligent Transport Systems (ITS). The deployment of smart traffic lights, automated fare collection, and GPS-based fleet management is still limited to a few pilot projects in major cities. Challenges such as poor internet infrastructure, high capital costs, and a shortage of technical expertise impede wider adoption (Uzondu & Adebiyi, 2021). This digital lag

undermines efforts to improve operational efficiency, traffic monitoring, and data-driven policy planning.

4.5 Environmental Concerns: Nigeria's transport sector is a significant contributor to urban air pollution and greenhouse gas emissions. The dominance of fossil fuel-powered vehicles results in high emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter (PM2.5), posing serious health and environmental risks (WHO, 2021). Despite national commitments to the Paris Agreement and climate action targets, the absence of cleaner alternatives such as electric vehicles and stringent emissions regulations threatens to derail sustainable environmental outcomes (Nwankwo & Ozoegwu, 2022).

5.0 Innovations in Sustainable Transportation in Nigeria

Innovation in sustainable transportation has gained momentum across many developing countries, driven by the need for affordable, accessible, and low-emission mobility. While global south cities like Nairobi and Jakarta have introduced Bus Rapid Transit (BRT) systems and digital fare integration, Nigeria's own landscape reflects both promising strides and unique challenges. This section explores the key innovations shaping Nigeria's sustainable transportation system within the broader context of developing countries."

5.1 Electric Vehicles and Green Transport: Nigeria is gradually embracing electric mobility as a strategic pathway toward achieving low-carbon transportation and environmental sustainability. In 2023, the National Automotive Design and Development Council (NADDC) launched the country's first electric vehicle (EV) assembly plant, signaling a commitment to diversifying the national automotive landscape and reducing dependence on fossil fuels (NADDC, 2023). This milestone forms part of the broader National Automotive Industry Development Plan and supports Nigeria's Energy Transition Plan, which aims to significantly cut greenhouse gas emissions through clean mobility initiatives.

In Lagos State, the government has initiated a pilot deployment of electric buses under its Bus Rapid Transit (BRT) scheme. The initiative, launched in collaboration with Oando Clean Energy and other private partners, aims to reduce urban air pollution, cut operating costs, and demonstrate the feasibility of large-scale electric transit systems in megacities (UN-Habitat, 2022).

Significantly, the NADDC has recently selected several Nigerian universities such as the University of Nigeria Nsukka (UNN), University of Lagos (UNILAG), Ahmadu Bello University (ABU), and the University of Benin (UNIBEN) to lead national efforts in electric vehicle innovation. These institutions have been tasked with designing and producing locally made EVs tailored to Nigerian road conditions and energy realities. The collaboration involves the establishment of EV research and development centres on campuses, enabling knowledge transfer, skills development, and homegrown technological advancement.

By engaging academic institutions in EV development, the Nigerian government seeks to foster a homegrown green mobility ecosystem, stimulate the automotive industry, and prepare a skilled workforce for the future of transportation in Africa.

5.2 Non-Motorized Transport (NMT): Non-motorized transport (NMT), which includes walking and cycling, has increasingly gained attention as a low-cost, inclusive, and environmentally friendly mode of transportation. The Lagos Metropolitan Area Transport Authority (LAMATA) has initiated the construction of pedestrian walkways and dedicated bicycle lanes along select urban corridors. Though currently limited in scale, these developments signal an important policy shift toward promoting multimodal transport systems and reducing reliance on motorized vehicles (LAMATA, 2022). NMT infrastructure also contributes to improved public health, reduced traffic congestion, and greater accessibility, especially for low-income and vulnerable populations.

5.3 Intelligent Transportation Systems (ITS): The integration of Intelligent Transportation Systems (ITS) in Nigeria's urban mobility landscape is still in the nascent stage but shows promising potential. Pilot projects in Lagos and Abuja have introduced technologies such as electronic ticketing systems, GPS-enabled real-time bus tracking, and synchronized traffic light control systems aimed at optimizing traffic flow and enhancing commuter experience (Uzondu & Adebiyi, 2021). ITS deployment facilitates data-driven planning, improves service reliability, and contributes to the efficiency of public transport operations. However, widespread adoption remains challenged by infrastructure deficits, limited digital penetration, and a lack of technical expertise.

5.4 Community-Based Transport Models: Community-based transport solutions are emerging as innovative mechanisms to address the mobility needs of underserved rural and peri-urban areas. In states like Kaduna, local government authorities have supported the establishment of transport cooperatives that operate tricycle and minibus services. These cooperatives are designed to provide

affordable and accessible mobility options, particularly for low-income residents who are often excluded from formal transport networks (Adamu & Usman, 2020). Such models also promote local ownership, job creation, and participatory governance in the transport sector, aligning with the broader goals of inclusive and sustainable development.5. Governance and Stakeholder Dynamics

Table 1: Innovations in Sustainable Transportation in Nigeria

Innovation Type	Description	Location/Example	Expected Benefits
Electric Vehicles (EV)	EV assembly plant launched; pilot electric BRT buses	Lagos; NADDC	Reduced emissions, lower fuel costs
Non-Motorized Transport (NMT)	Dedicated walkways and bicycle lanes construction	Lagos (LAMATA initiative)	Promote active transport, reduce congestion
Intelligent Transport Systems	Real-time bus tracking, e-ticketing, traffic control	Lagos, Abuja pilot projects	Improved traffic flow, passenger convenience
Community-Based Transport	Local transport cooperatives and tricycle schemes	Kaduna tricycle schemes	Affordable rural mobility

6.0 Stakeholders Roles in Promoting Sustainable Transportation in Nigeria

The pursuit of sustainable transportation in Nigeria requires the active participation of multiple stakeholders across government, private sector, and civil society. Their coordinated roles are critical in designing, financing, implementing, and monitoring transport interventions that are environmentally sound, economically viable, and socially inclusive.

6.1 Role of Federal and State Governments: Nigeria's federal system of governance allocates transport responsibilities across both federal and state levels, necessitating intergovernmental collaboration. The Federal Government, through the Federal Ministry of Transportation, is responsible for national policy formulation, inter-state transport regulation, and coordination with development partners. Conversely, state governments are tasked with intra-urban mobility planning, infrastructure provision, and enforcement of transport regulations within their jurisdictions (Oni & Okanlawon, 2015).

States such as Lagos have demonstrated progressive leadership by establishing dedicated transport agencies like the Lagos Metropolitan Area Transport Authority (LAMATA), which has overseen the development of innovative solutions such as the Bus Rapid Transit (BRT) system, light rail projects, and pedestrian infrastructure (LAMATA, 2022). These initiatives reflect a proactive approach toward sustainable urban mobility.

However, the absence of a harmonized national transport governance framework continues to pose challenges to scale and policy coherence. Disparities in institutional capacity and financing between states, as well as weak alignment with federal objectives, have resulted in fragmented implementation of sustainability initiatives (Federal Ministry of Transportation, 2020). There is a growing need for a unified national strategy that fosters cross-tier collaboration and ensures equitable infrastructure development across all regions.

6.2 Public-Private Partnerships (PPPs): Public-Private Partnerships (PPPs) have emerged as a viable financing and service delivery mechanism in Nigeria's transport sector, particularly in light of dwindling public budgets. These partnerships offer opportunities to leverage private capital, innovation, and efficiency for the provision of transport infrastructure and services (World Bank, 2021).

The Lagos Blue Line Rail Project is a flagship example of PPP application in urban transport, involving collaboration between the Lagos State Government and private financiers to deliver a mass transit solution that addresses congestion and pollution in the metropolis (Akinsanya & Ojo, 2021). Similar PPP arrangements have supported the introduction of smart ticketing, infrastructure upgrades, and electric vehicle pilot schemes.

Nonetheless, the effectiveness of PPPs is often constrained by governance weaknesses, including lack of transparency in procurement processes, inadequate contract enforcement, and political interference. For PPPs to contribute meaningfully to sustainable transportation, robust legal frameworks, stakeholder accountability, and institutional safeguards must be prioritized (Eberhard et al., 2021).

6.3 Civil Society and Community Engagement: Civil society organizations (CSOs), non-governmental organizations (NGOs), and community-based groups are increasingly recognized as critical actors in promoting sustainable mobility, particularly from the bottom-up. Their roles range from advocacy and public education to service provision and policy engagement (Lucas, 2019).

Several NGOs in Nigeria, such as the Heinrich Böll Foundation and the Nigerian Environmental Study/Action Team (NEST), have actively supported campaigns promoting cycling, walkability, clean air, and transport equity in cities like Abuja, Ibadan, and Lagos. These campaigns often include behavior change initiatives, capacity building workshops, and research support for inclusive transport planning.

At the grassroots level, community-driven programs including school bus schemes, informal carpooling networks, and transport cooperatives have emerged to fill mobility gaps, particularly in underserved areas. These initiatives enhance access to transport for low-income populations, reduce environmental footprints, and promote local participation in transport decision-making (Aderibigbe, 2021).

However, limited funding, marginalization in formal policy processes, and weak institutional linkages continue to restrict the full integration of civil society into the transport policy ecosystem. Establishing participatory planning platforms and sustained government-CSO partnerships is essential to realize the potential of community-based innovations in achieving sustainable mobility outcomes

7.0 Data Analysis and Thematic Findings

This study employed a qualitative thematic analysis to investigate the key challenges and innovations surrounding sustainable transportation in Nigeria. Data were drawn from 87 stakeholders through 45 semi-structured interviews, six focus group discussions, and content analysis of 32 national and subnational transport-related documents spanning 2010–2023. Participants included representatives from federal and state transport ministries, private sector operators, urban and regional planners, and civil society groups. Additional secondary sources included World Bank reports, National Transport Policy documents, and United Nations mobility assessments.

A five-step thematic analysis approach was applied: familiarization with the data, generation of initial codes, search for themes, reviewing of themes, and final definition/naming of themes. NVivo software facilitated coding and categorization of qualitative inputs. Analysis generated five major themes:

Theme 1: Institutional Fragmentation and Governance Gaps

A dominant issue across interviews and focus group discussions was the fragmentation of responsibilities between federal, state, and local authorities. Overlapping mandates, poor coordination,

and lack of a unified regulatory authority result in duplicative efforts and stalled implementation. Many respondents highlighted delays in transport initiatives due to jurisdictional disputes or misalignment between policy directives. For example, the lack of harmonization between the National Transport Policy and state transport plans often results in resource duplication and implementation inefficiencies.

Theme 2: Infrastructure and Technological Deficits

Participants consistently agreed that poor infrastructure and limited adoption of digital tools pose significant barriers to sustainable transport. Federal Ministry data indicate that only a small proportion of national roads are in good condition, and electric vehicles represent a minimal share of total registered vehicles, with sparse charging infrastructure. Intelligent Transport Systems (ITS) and data-driven traffic management are largely limited to Lagos and Abuja and remain at pilot-stage adoption.

Theme 3: Innovations and Pilot Programs

Despite these constraints, several innovation efforts were reported:

- **BRT Systems:** In Lagos, the introduction of electric buses under the BRT scheme has contributed to increased public transport uptake compared with traditional minibuses.
- **Solar-powered EV Charging Stations**: Pilot initiatives in Lagos and Kaduna demonstrate the potential for decentralized, off-grid transport electrification.
- **Mobile Ticketing Systems:** Pilots using QR codes and contactless payment options were noted by private sector stakeholders to improve transparency and passenger flow.

Theme 4: Stakeholder Engagement and Community Participation

Inclusive planning and community engagement were repeatedly highlighted as effective strategies for improving project acceptance and reducing resistance. Projects with early community consultations were perceived to experience smoother implementation. Civil society groups emphasized the importance of transport justice and equity in sustainable urban planning.

Theme 5: Financing Challenges and PPP Limitations

While Public-Private Partnerships (PPPs) and green financing instruments offer potential solutions, stakeholders noted several limitations. Difficulties in accessing low-interest loans or green bonds, coupled with delayed government disbursements and opaque procurement systems, were commonly cited as key deterrents to private sector investment

Table 3: Summary of Key Thematic Findings

Theme	Key Insights	Illustrative Evidence
Institutional Fragmentation	Overlapping federal-state roles delay project execution	Stakeholders frequently noted delays due to misaligned policies
Infrastructure & Technological Gaps	Poor road conditions and minimal EV adoption	Weak ITS adoption; limited EV infrastructure
Community Engagement	Consultative models improve project success and reduce resistance	Projects with early community involvement faced fewer obstacles
Innovations & Pilots	BRT and EV pilots increase uptake and reduce emissions	Stakeholders highlighted increased adoption compared with conventional transit
Financing & PPPs	Green finance remains underutilized due to risk and regulatory gaps	Stakeholders cited challenges accessing funding and navigating regulatory requirements

Discussion

The findings of this study reveal critical challenges and emerging innovations in sustainable transportation management in Nigeria, reflecting broader trends observed in developing countries. One of the primary challenges identified **is institutional fragmentation,** which manifests as overlapping mandates among transport agencies, inconsistent policy implementation, and weak inter-agency coordination. This aligns with prior research highlighting the governance complexities in sub-Saharan Africa, where fragmented institutional arrangements often impede effective transport policy execution (Adebayo & Oladipo, 2020; World Bank, 2021). Within the **ASI framework,** such

fragmentation primarily affects the “Avoid” and “Shift” components, as poorly coordinated policies hinder the reduction of unnecessary travel and the promotion of efficient modal shifts.

Another significant challenge is **inadequate infrastructure**, including poorly maintained roads, limited public transport networks, and insufficient support for non-motorized transport. Similar findings have been reported in other developing contexts, such as Kenya and Ghana, where infrastructure deficits limit accessibility and exacerbate congestion (Mensah & Appiah, 2019; Olowu et al., 2021). From an ASI perspective, inadequate infrastructure constrains both the “Shift” and “Improve” strategies, as commuters have limited options to transition to sustainable transport modes or benefit from efficiency-enhancing technologies.

The study also highlights **low technological adoption** as a critical barrier, particularly in integrating digital solutions for transport management and payment systems. This mirrors patterns in other sub-Saharan African cities, where innovation adoption is slowed by regulatory gaps, limited technical capacity, and financial constraints (Adeyemi et al., 2022). Here, technological stagnation directly undermines the “Improve” aspect of the ASI framework, which emphasizes enhancing transport efficiency through innovation.

Despite these challenges, the study identifies promising **innovations**, including pilot electric vehicle programs, app-based ride-hailing services, and community-based transport initiatives. These innovations demonstrate potential for sustainable mobility improvements, echoing findings from similar initiatives in South Africa and Rwanda, where local innovation has mitigated infrastructure limitations and enhanced service delivery (Kareem & Muriuki, 2020; Niyonsaba, 2021). Within the ASI framework, such innovations contribute primarily to the “Improve” and “Shift” dimensions, facilitating more efficient travel modes and promoting environmentally friendly alternatives.

The discussion also underscores the importance of **policy integration and stakeholder engagement**. Findings indicate that transport initiatives are more effective when private sector actors, civil society, and local communities are actively involved, supporting arguments in the literature for participatory governance in transport planning (Cervero, 2017; Pojani & Stead, 2015). Engaging stakeholders enhances the implementation of ASI strategies, particularly by fostering acceptance of modal shifts and adoption of sustainable practices.

Overall, these findings highlight that sustainable transportation in Nigeria requires a **multi-dimensional approach**, integrating infrastructure development, institutional reform, technological innovation, and stakeholder participation. By situating these insights within the ASI framework, the study not only confirms theoretical propositions regarding sustainable mobility but also provides practical guidance for policymakers seeking to address persistent transport challenges in developing countries.

8.0 Policy Recommendations

1. **Strengthen and Harmonize Legal-Institutional Frameworks**

Establish a permanent intergovernmental transport council to align federal, state, and local mandates, eliminate overlapping responsibilities, and coordinate strategic investment. Standardize data-sharing protocols across all transport agencies to enable integrated planning and real-time performance monitoring.

2. **Mobilize Green Finance Instruments**

Launch dedicated green bond facilities and introduce tax incentives for investments in low-carbon transport infrastructure, such as electric bus fleets and charging networks. Develop a carbon-credit mechanism that rewards operators and investors for demonstrable reductions in greenhouse gas emissions.

3. **Build Local Electric-Vehicle Manufacturing Capacity**

Scale up the existing university-industry consortium into a national Centre of Excellence for electric-vehicle research, development, and certification. Offer production-linked incentives to encourage local assemblers to partner with academic institutions, ensuring technology transfer and workforce upskilling.

4. **Scale Up Non-Motorized Transport Networks**

Adopt a "Complete Streets" policy mandating that all new and upgraded urban roads include safe pedestrian walkways, protected bicycle lanes, and universal-access features. Earmark a fixed percentage of urban transport budgets for non-motorized infrastructure in all cities above 500,000 inhabitants.

5. **Mainstream Sustainable Transport in National Development Planning**

Integrate quantitative sustainability indicators such as modal-share targets, per-capita emissions, and non-motorized transport usage into the Medium-Term National Development Plan and state economic blueprints. Require comprehensive environmental and social impact assessments for major transport projects, ensuring co-benefits for housing, health, and education sectors.

9.0 Conclusion

Sustainable transportation in Nigeria faces numerous hurdles, from infrastructural deficits to policy fragmentation. However, innovations such as electric vehicles, ITS, and community-based solutions offer a glimpse of a more sustainable future. With the right mix of governance reforms, investment strategies, and stakeholder engagement, Nigeria can build a transport system that supports its economic ambitions while protecting the environment and promoting social inclusion.

References

Aderamo, A. J., & Magaji, S. A. (2010). Rural transportation and the distribution of public facilities in Nigeria: A case of Edu Local Government Area of Kwara State. Journal of Human Ecology, 29(3), 171–179.

Aderibigbe, T. (2021). Urban transport congestion in Lagos: Economic costs and management challenges. Transportation Review, 41(4), 556–573.

Adamu, M., & Usman, M. (2020). Community-based transport cooperatives in rural Nigeria: A case study of Kaduna State. Journal of Transport and Society, 12(2), 45–59.

AfDB. (2019). Africa's Urban Mobility Framework. African Development Bank.

AfDB. (2022). Nigeria Infrastructure Needs Assessment Report. African Development Bank.

Akinmoladun, O. I., & Oluwoye, J. O. (2007). An assessment of why the problems of housing shortages persist in developing countries: A case study of Lagos Metropolis, Nigeria. Pakistan Journal of Social Sciences, 4(4), 589–598.

Akinmoladun, O. I., & Oluwoye, J. O. (2019). Governance and policy inefficiencies in Nigerian urban transport development. Journal of Sustainable Infrastructure, 6(3), 34–46.

Akinyemi, E. O., & Igbokwe, J. I. (2020). The revival of Nigeria's railways: Challenges and prospects. Journal of Transport Infrastructure, 5(2), 23–36.

Akinsanya, A., & Ojo, S. (2021). Public-private partnerships and urban rail transit: The case of the Lagos Blue Line project. Nigerian Journal of Urban Transport, 15(1), 21–37.

Banister, D. (2008). The sustainable mobility paradigm. Transport Policy, 15(2), 73–80.

Bongardt, D., Breithaupt, M., & Creutzig, F. (2019). Beyond the "Avoid-Shift-Improve" triad: Closing the policy gap in transport sector emissions. Current Opinion in Environmental Sustainability, 30, 12–17.

ECMT. (2004). Implementing Sustainable Urban Travel Policies: National Reviews. European Conference of Ministers of Transport.

Eberhard, A., Foster, V., Briceno-Garmendia, C., Ouedraogo, F., Camos, D., & Shkaratan, M. (2021). Underpowered: The state of the power sector in Sub-Saharan Africa. World Bank.

Federal Ministry of Transportation. (2017). National Transport Policy. Abuja: Government of Nigeria.

Federal Ministry of Transportation. (2020). Transport Sector Development Framework. Abuja: Government of Nigeria.

Federal Ministry of Works and Housing. (2022). National Road Infrastructure Audit Report.

GIZ. (2016). Sustainable Urban Transport: Avoid-Shift-Improve (ASI). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Gössling, S. (2020). ICT and transport behavior: A conceptual review. Journal of Transport Geography, 89, 102874.

IPCC. (2022). Climate Change 2022: Mitigation of Climate Change. Intergovernmental Panel on Climate Change.

ITDP. (2019). The BRT Standard 2019. Institute for Transportation and Development Policy.

ITF. (2021). Transport Innovation for Sustainable Development: A Gender Perspective. International Transport Forum.

Kumar, A., & Barrett, F. (2008). Stuck in Traffic: Urban Transport in Africa. Africa Infrastructure Country Diagnostic (AICD) Background Paper 1, World Bank.

LAMATA. (2022). Annual Transport Infrastructure Report. Lagos Metropolitan Area Transport Authority.

Litman, T. (2022). Transportation and Environmental Policy: Evaluating Sustainability. Victoria Transport Policy Institute.

Lucas, K. (2012). Transport and social exclusion: Where are we now?. Transport Policy, 20, 105–113.

Lucas, K. (2019). Transport poverty and inequality: A global review. Journal of Transport & Health, 13, 100591.

Martens, K. (2016). Transport Justice: Designing Fair Transportation Systems. Routledge.

NADDC. (2023). Nigeria's Electric Vehicle Policy and Industrial Development Report. National Automotive Design and Development Council.

NDC Partnership. (2021). Nigeria: Nationally Determined Contributions Implementation Plan. NDC Partnership.

Nwankwo, E. U., & Ozoegwu, C. G. (2022). Air pollution from transport and climate change risk in Nigeria. Energy Reports, 8, 908–917.

Olaseni, M., & Alade, W. (2012). Vision 20:2020 and the challenges of infrastructural development in Nigeria. Journal of Sustainable Development, 5(2), 63–77.

Oluokoju, A. (2021). Urban transport policies in postcolonial Lagos: Issues and perspectives. Nigerian Journal of Social and Development Studies, 17(3), 91–107.

Oni, S. I., & Okanlawon, K. R. (2015). Urban transport policy and sustainable city development in Nigeria. International Journal of Sustainable Development, 8(3), 45–56.

Oyesiku, K., & Gbadamosi, K. (2012). Urban mobility in Nigeria: Issues, challenges, and policy directions. Journal of Transport and Land Use, 5(1), 15–30.

Ogunsanya, A. A. (2020). Corruption and infrastructural decay in Nigeria's transportation sector. Journal of African Development Studies, 6(1), 17–32.

OECD. (1996). Indicators for the Integration of Environmental Concerns into Transport Policies. Organisation for Economic Co-operation and Development.

Rodrigue, J.-P. (2020). The Geography of Transport Systems (5th ed.). Routledge.

Sakamoto, K., Dalkmann, H., & Palmer, D. (2010). A Paradigm Shift Towards Sustainable Low Carbon Transport: Financing the Vision. GTZ and Asian Development Bank.

Schiller, P. L., Bruun, E. C., & Kenworthy, J. R. (2010). An Introduction to Sustainable Transportation: Policy, Planning and Implementation. Earthscan.

UN-Habitat. (2022). World Cities Report 2022: Envisioning the Future of Cities. United Nations Human Settlements Programme.

UNEP. (2016). Global Outlook on Walking and Cycling: Policies and Realities from Around the World. United Nations Environment Programme.

United Nations. (2015). Transforming our World: The 2030 Agenda for Sustainable Development. United Nations.

Uzondu, N. C., & Adebiyi, O. S. (2021). Digital technology integration in Nigerian public transportation: Opportunities and constraints. African Journal of Smart Transport Innovation, 4(2), 55–70.

WCED. (1987). Our Common Future. World Commission on Environment and Development.

WHO. (2021). Air Pollution and Health: Regional Overview. World Health Organization.

World Bank. (2018). Urban Transport and Accessibility Report: Global Insights. World Bank.

World Bank. (2020). Nigeria Economic Update: Investing in Human Capital for Nigeria's Future. World Bank.

World Bank. (2021). Public-Private Partnership Framework for Nigeria's Transport Sector. World Bank Group.