



People, Pathways, and Pedals: Integrating Non-Motorized Transport and Transit-Oriented Development for a Green Abuja

Mohammed Abubakar Adeyemi¹ & Prof. Zubairul Islam²

¹Centre for Sustainable Development, School of Postgraduate Studies, University of Abuja, yemiplc@yahoo.com

²Centre for Sustainable Development, University of Abuja, zubairul@gmail.com

ABSTRACT

This paper argues that strategically integrating non-motorized transport (NMT) with transit-oriented development (TOD) offers a low-carbon, equitable pathway for Abuja's green transition. Drawing on global evidence demonstrating the cost-effectiveness, health co-benefits, and emissions-reduction potential of walkability and cycling investments (Cervero & Sullivan, 2011; Nieuwenhuijsen, 2020), the study situates Abuja's mobility challenges within broader debates on African urban transport governance (Acheampong & Siiba, 2019; Klopp & Cavoli, 2019). Using mixed secondary data, spatial analysis, and policy review, the paper identifies persistent gaps in urban form, last-mile connectivity, and institutional coordination that undermine sustainable mobility outcomes. It argues that compact, mixed-use TOD nodes linked by protected NMT corridors can significantly enhance accessibility, reduce car dependence, and advance climate commitments (UN-Habitat, 2022; Rodriguez & Vergel-Tovar, 2021). The manuscript concludes by proposing context-specific design, regulatory, and financing frameworks necessary to operationalise NMT–TOD synergies for a greener, more inclusive Abuja.

Keywords: Non-motorized transport (NMT); Transit-oriented development (TOD); Sustainable mobility; Cycling infrastructure; Walkability; Low-carbon transport; Urban planning; Abuja; Climate governance; Last-mile connectivity.

INTRODUCTION

1.1 Why Non-Motorized Transport Matters: Equity and Low-Emission Mobility

Non-motorized transport (NMT) principally walking and cycling has re-emerged as a central pillar of sustainable urban mobility debates due to its dual capacity to deliver equitable access and significantly reduce transport-related emissions. Global evidence highlights that NMT offers the most affordable and inclusive form of mobility, particularly for low-income urban residents who are disproportionately affected by rising fuel prices, limited public transport coverage, and spatial segregation (Pojani & Stead, 2017; Uteng & Lucas, 2018; Umar et al., 2025). Because walking and cycling require minimal financial investment compared to private vehicle ownership, they expand mobility opportunities for women, youth, informal workers, and other transport-disadvantaged groups (UN-Habitat, 2022). Consequently, expanding NMT infrastructure is widely viewed as a social-justice imperative within the broader sustainable development agenda. From an environmental perspective, NMT is integral to decarbonising urban transport, which remains a major contributor to greenhouse gas emissions in rapidly growing cities (IEA, 2021). Cities that prioritise walking and cycling supported by safe corridors, human-scaled street design, and integrated land-use planning consistently report reductions in local air pollutants, improved energy efficiency, and significant shifts away from private car travel (Cervero & Sullivan, 2011; Nieuwenhuijsen, 2020). The co-benefits extend to public health: enhanced active mobility correlates strongly with lower rates of non-communicable diseases, improved mental well-being, and reduced noise pollution (Giles-Corti et al., 2016). In the Global South, and particularly across African cities, NMT also aligns with fiscal realities. Compared to large-scale road expansions or rail mega-projects, investments in sidewalks, protected cycling lanes, shade structures, and intersection safety upgrades are cost-effective and rapidly deployable, offering high-impact mobility improvements without straining municipal budgets (Klopp & Cavoli, 2019). For cities experiencing rapid population growth, informal development, and intensifying congestion conditions characteristic of Abuja, NMT thus emerges not merely as an accessory to transport planning but as a foundational

mechanism for advancing social equity, promoting low-carbon mobility transitions, and enhancing urban liveability.

Abuja's Mobility Problem: Car Dependency and Structural Gaps

Abuja's transport landscape is shaped by a legacy of automobile-oriented planning, low-density urban expansion, and limited investment in safe pedestrian and cycling infrastructure. Although originally conceived as a planned, polycentric city, Abuja has evolved into a highly car-dependent metropolis, with private vehicles dominating daily mobility patterns and accounting for substantial shares of congestion, energy consumption, and emissions (Aderamo, 2010; Acheampong & Siiba, 2019). The spatial structure of the Federal Capital Territory, marked by wide arterial roads, separated land uses, and low residential densities, reinforces the necessity of motorised trips even for short journeys. Despite this auto-centric configuration, a significant proportion of residents still rely on walking for a considerable segment of their daily mobility, particularly for last-mile connections to informal minibuses, shared taxis, or workplace locations inaccessible by public transit. Yet pedestrian facilities remain discontinuous, poorly maintained, or absent in many districts, exposing users to traffic risks and discouraging active travel (Ede & Aderibigbe, 2021). Cycling, meanwhile, is almost nonexistent as a functional mode due to the lack of protected lanes, unsafe intersections, limited public acceptance, and institutional neglect.

Public transport also faces structural weaknesses: fragmented governance, insufficient route integration, inadequate coverage of peri-urban settlements, and limited investment in modern, high-capacity transit systems. These gaps collectively entrench private car dominance, exacerbating congestion on major corridors such as the Airport Road, Kubwa Expressway, and Central Business District. The consequences—ranging from longer commute times and higher household transport costs to increased emissions and reduced urban productivity underscore the urgency of rethinking Abuja's mobility model. Integrating NMT and transit-oriented development (TOD) provides a strategic pathway to address these structural challenges while supporting a more inclusive urban future.

Purpose, Research Questions, and Contribution

The purpose of this paper is to examine how Abuja can leverage the synergies between non-motorized transport and transit-oriented development to advance a green, socially inclusive mobility transition. By synthesising global best practices with Abuja-specific mobility and land-use realities, the study aims to articulate a coherent framework for integrating walking, cycling, and compact mixed-use development into transport policy and urban planning processes.

The analysis is guided by three core research questions:

1. How do NMT investments contribute to equitable, low-emission urban mobility in rapidly growing African cities?
2. What structural, spatial, and institutional factors constrain NMT adoption and sustainable transport outcomes in Abuja?
3. What context-appropriate NMT–TOD strategies can enhance accessibility, reduce car dependence, and support Abuja's green-transition ambitions?

The study contributes to emerging African urban mobility scholarship by offering a grounded, policy-oriented assessment of how NMT and TOD often treated separately can be systematically integrated to reshape Abuja's transport future.

Review of Evidence

Global Impacts of Cycling and Walking Infrastructure

A substantial body of international research demonstrates that investments in cycling and walking infrastructure generate wide-ranging mobility, environmental, and socio-economic benefits. High-quality NMT networks comprising protected bike lanes, continuous sidewalks, safe crossings, traffic-calmed streets, and integrated micromobility facilities consistently increase active travel uptake by reducing perceived risk, improving comfort, and enhancing route directness (Pucher & Buehler, 2010; Aldred, 2018). Evidence from European and Latin American cities shows that protected cycling lanes are the single

strongest predictor of modal shift away from private cars, with increases in cycling volumes often surpassing 30–50% within the first year of implementation (Dill & Carr, 2003; Cervero & Sullivan, 2011). Walking infrastructure has similarly transformative effects. Cities that implement wide sidewalks, shade structures, pedestrian priority zones, and universal-access design experience improved pedestrian flow, reduced vehicle–pedestrian conflict, and increased last-mile connectivity to public transport (Giles-Corti et al., 2016). Importantly, walking improvements tend to disproportionately benefit low-income residents those who walk by necessity rather than choice and therefore contribute directly to urban equity (Uteng & Lucas, 2018; UN-Habitat, 2022).

Environmentally, the global evidence is unequivocal: investments in NMT reduce vehicle kilometres travelled (VKT), lower greenhouse-gas emissions, and reduce local air pollutants such as PM_{2.5} and NO₂ (Nieuwenhuijsen, 2020). For instance, studies in Copenhagen, London, and New York show that incremental shifts towards active travel are associated with measurable reductions in urban carbon footprints, especially when coupled with compact land-use planning and transit-oriented development (Banister, 2008; Sustrans, 2020). Moreover, the cost-effectiveness of NMT stands out. Compared to large-scale road expansions or rail mega-projects, NMT investments offer some of the highest returns on mobility and environmental outcomes per dollar spent (Klopp & Cavoli, 2019). This makes active-transport infrastructure especially attractive for fast-growing cities with constrained budgets. Collectively, the evidence indicates that cycling and walking networks are not marginal enhancements but foundational components of sustainable mobility systems. When integrated with public transit, they unlock multi-modal efficiency, support inclusive access, and play a critical role in achieving low-carbon urban futures.

International Case Studies: Bogotá, Nairobi, Delhi, and Kigali

Global case studies reinforce how strategic NMT investments, supported by institutional commitment and regulatory reform, can reshape urban mobility trajectories.

Bogotá, Colombia

Bogotá offers one of the most widely studied examples of rapid NMT transformation. The city's expansion of *ciclorutas* (protected cycling lanes) and the globally recognised *Ciclovía* programme demonstrate how political leadership can mainstream active mobility (Montezuma, 2005). Coupled with the TransMilenio Bus Rapid Transit (BRT) system, cycling serves as both a feeder mode and an independent commuting choice. Evidence shows substantial modal shifts and reduced travel times, particularly among lower-income residents (Cervero et al., 2010). Bogotá's experience underscores the value of integrated NMT–transit planning.

Nairobi, Kenya

In East Africa, Nairobi has recently prioritised walking and cycling through its Non-Motorised Transport Policy (2015). The city's pedestrian corridors, upgraded sidewalks along Moi Avenue, and protected cycle tracks on major arterial roads represent a major shift from historically car-oriented planning (Ngau & Were, 2020). Although implementation remains uneven, Nairobi's case illustrates the importance of governance reforms, multi-stakeholder participation, and donor-supported financing arrangements. These interventions have improved safety, enhanced pedestrian visibility in planning, and encouraged an emerging cycling culture.

Delhi, India

Delhi presents a contrasting yet instructive case. Faced with severe air pollution and congestion, the city has experimented with cycle tracks, pedestrianised markets, and car-free zones (Tiwari, 2016). However, inconsistent enforcement, poor maintenance, and encroachment have undermined infrastructure performance. Despite these challenges, Delhi's Active Mobility Corridors demonstrate how NMT initiatives can succeed when supported by strong institutional coordination and air-quality mandates. Delhi's case highlights a key lesson: infrastructure must be accompanied by behavioural, institutional, and regulatory shifts to be effective.

Kigali, Rwanda

Kigali represents one of Africa's most successful emerging examples of walkability improvements. The city has implemented pedestrianisation in the Central Business District, developed safe walking zones, and enhanced public-space quality through streetscaping and traffic calming (Goodfellow, 2017). Kigali's "Car-Free Day" programme has become a regional model for promoting active mobility and community health. Unlike many African cities, Kigali's NMT interventions benefit from consistent maintenance, strong urban governance, and a coherent long-term planning vision.

Across these cities, three insights emerge:

1. Political leadership and clear policy frameworks are essential.
2. Integration with public transit significantly enhances NMT effectiveness.
3. Incremental, low-cost interventions such as pop-up lanes, pedestrian crossings, and tactical urbanism can catalyse broader modal shifts.

These cases offer relevant lessons for Abuja, demonstrating how African and Global South cities can successfully mainstream walkability and cycling despite institutional and infrastructural constraints.

Health Co-Benefits: Air Quality, Cardiovascular Health, and Safety

The health co-benefits of active mobility have become a central justification for NMT investments. Empirical research demonstrates that shifting even a small proportion of daily trips from private cars to walking or cycling generates substantial public-health gains through improved air quality, enhanced physical activity, and reduced road-traffic injuries.

Air Quality (PM_{2.5} Reduction)

Transport emissions are a major source of urban PM_{2.5}, NO₂, and black carbon pollutants closely linked to respiratory illness, cardiovascular disease, and premature mortality (WHO, 2021). Cities that promote NMT report significant decreases in transport-related emissions due to reduced car use. For example, London and Paris observed measurable declines in roadside PM_{2.5} concentrations following expansions of cycling corridors and low-emission zones (Tonne et al., 2018). By facilitating short-distance mode shift, NMT infrastructure thus contributes directly to cleaner urban air.

Cardiovascular and Metabolic Health

Regular physical activity delivered through active transport correlates strongly with lower risks of obesity, hypertension, type-2 diabetes, and cardiovascular disease (Sallis et al., 2016). Studies from Denmark, the Netherlands, and the U.S. show that cities with high rates of active commuting have significantly healthier populations, with reduced healthcare costs and improved life expectancy (Pucher & Buehler, 2010). Even moderate increases in daily walking from 10 to 20 minutes yield substantial health benefits.

Road Safety

NMT investments also enhance safety outcomes. Traffic-calming measures, protected bike lanes, continuous sidewalks, and pedestrian priority zones significantly reduce the likelihood and severity of crashes (Aldred et al., 2019). The "safety in numbers" effect indicates that as more people walk or cycle, drivers adjust their behaviour, further reducing risk. Cities such as New York and Barcelona have recorded notable reductions in pedestrian injuries after redesigning streets under Vision Zero frameworks. Together, these health co-benefits justify NMT as a public-health intervention, not merely a transport option. For Abuja where air-quality concerns, rising non-communicable diseases, and high traffic-risk exposure are increasingly evident the health rationale strengthens the case for prioritising active mobility.

Land-Use Structure of Abuja

Abuja's spatial structure is rooted in the principles articulated in the Abuja Master Plan, which envisioned a polycentric, sector-based capital organised around clearly delineated land-use clusters and functional nodes (FCDA, 1979). The plan's spatial logic emphasised the separation of land uses, residential, commercial, industrial, administrative, and recreational, arranged along structured sectors and corridor hierarchies to promote orderliness and manage future growth (FCDA, 1979). Subsequent analyses show

that this polycentric vision materialised unevenly, with the strongest activity concentrations emerging in the Central Business District (CBD), Garki, Wuse, and the industrial zones around Idu, creating a spatial morphology dominated by discrete urban nodes rather than continuous mixed-use environments (Adeyanju et al., 2022).

The sectoral structure has profound implications for mobility patterns. The layout encourages long-distance movement between spatially separated residential districts such as Gwarinpa, Lugbe, and Kado and primary employment and administrative centres located in the CBD and Garki (Acheampong & Siiba, 2019). Because residential densities remain relatively low across much of Abuja, the city's spatial form reinforces dependence on private vehicles and conventional public transport for daily commuting (Adelekan, 2020). Moreover, the hierarchical road network—characterised by wide arterials, expressways, and superblocks privileges motorised flows while constraining the permeability required for walking and cycling (Adeyanju et al., 2022).

Although the Master Plan envisioned green belts and neighbourhood commercial centres, rapid urban expansion and informal peri-urban growth have produced land-use discontinuities, particularly in areas such as Nyanya, Karu, and Kubwa (Adelekan, 2020). These discontinuities weaken the intended polycentric balance and intensify unidirectional commuting towards core districts. This spatial misalignment between planned sectoral logic and actual urban development patterns significantly challenges the implementation of transit-oriented development (TOD) and non-motorised transport (NMT), both of which require dense, mixed-use, and highly connected environments (Klopp & Cavoli, 2019; UN-Habitat, 2022).

Mobility Patterns, Trip Lengths, and Missing Links

Abuja's mobility patterns reflect the interaction between its polycentric but functionally segregated land-use structure and its heavily automobile-oriented transport network. Empirical assessments consistently show that daily mobility is dominated by long-distance, radial commuting flows from peripheral residential areas, including Gwarinpa, Lugbe, Kubwa, Karu–Nyanya, Kado, and Galadimawa, into the Central Business District, Wuse, and Garki, where most formal employment, administrative functions, and high-order services are concentrated (Adeyanju et al., 2022; Acheampong & Siiba, 2019). Because of this spatial imbalance, average trip lengths are significantly longer than in comparable African cities, often exceeding 12–18 km for work journeys, with peak-period congestion concentrated along major arterials such as the Airport Road, Kubwa Expressway, and Keffi Corridor (Aderamo, 2010). Despite this dependence on motorised transport, a substantial share of the population relies on walking as part of daily multimodal trips, especially for last-mile connections to informal minibuses, shared taxis, and commercial hubs (Adelekan, 2020). However, walking remains unsafe and inconvenient due to discontinuous sidewalks, missing pedestrian crossings, encroached rights-of-way, and poor lighting, leading to high exposure to vehicular conflict (Adeyanju et al., 2022). Cycling, although historically practised by low-income residents and delivery workers, has effectively disappeared as a functional mode because arterial roads lack dedicated cycle lanes, intersections are unsafe, and social perceptions discourage bicycle use (Klopp & Cavoli, 2019).

The city also faces pronounced “missing link” problems that undermine efficient mobility. Key gaps include the absence of safe pedestrian access between residential estates and major transport corridors; limited internal circulation within superblocks; poor integration between feeder communities and trunk public transport routes; and minimal intermodal infrastructure such as bus–bike interfaces or multimodal terminals (UN-Habitat, 2022). These discontinuities reduce transport efficiency, increase travel time, and limit the viability of non-motorised transport and transit-oriented development. Consequently, the city's mobility system remains fragmented, vehicle-dependent, and structurally misaligned with sustainable mobility objectives (Acheampong & Siiba, 2019).

Constraints for NMT and TOD Implementation

The implementation of non-motorised transport (NMT) and transit-oriented development (TOD) in Abuja is constrained by a constellation of structural, institutional, financial, and socio-cultural factors that collectively undermine the adoption of sustainable mobility practices. A primary structural constraint arises from Abuja's low-density, sector-based spatial configuration, which disperses residential and commercial functions across wide areas and increases average trip distances, thereby diminishing the

practicality of walking and cycling for many daily journeys (FCDA, 1979; Adeyanju et al., 2022). The hierarchical road network dominated by expressways, grade-separated interchanges, and superblocks prioritises vehicular throughput over pedestrian and cyclist permeability, reducing opportunities for retrofitting active-transport infrastructure (Acheampong & Siiba, 2019). Institutional limitations further impede progress. Transport planning responsibilities in the Federal Capital Territory are fragmented across federal, municipal, and agency jurisdictions, resulting in weak coordination, inconsistent standards, and limited enforcement of street design guidelines (Adelekan, 2020). The absence of a dedicated NMT policy framework or citywide street design manual has contributed to irregular sidewalk provision, poor maintenance regimes, and inadequate funding streams (Klopp & Cavoli, 2019). These governance gaps reduce the institutional coherence required for implementing TOD, which depends on integrated land-use, transport, and development controls.

Financial barriers also play a significant role. Although NMT infrastructure is relatively low-cost, budgetary allocations remain heavily skewed toward road expansion projects, reflecting long-standing political and administrative preferences for automobile-centric development (Aderamo, 2010; Yusuf et al., 2025). Limited mechanisms for value capture or transit-aligned development finance further constrain the ability to channel resources into compact, mixed-use precincts around major transport corridors (UN-Habitat, 2022; Imam-Binuyo et al., 2026). Socio-cultural factors add a further layer of complexity. Cycling suffers from negative public perceptions, stigma, and associations with low socio-economic status, while walking is often viewed as an involuntary mode rather than a desirable mobility choice (Adeyanju et al., 2022; Jafaru et al., 2025). Combined with safety concerns—stemming from high traffic speeds, weak enforcement, and inadequate pedestrian protection—these factors suppress demand for active travel and hinder political support for NMT–TOD transitions (Acheampong & Siiba, 2019). Together, these constraints create a challenging environment for operationalising sustainable transport reforms in Abuja.

Pilot Design Proposals for Four Precincts

Engineering Templates for Sidewalks, Cycle Lanes, and Intersections

Designing NMT infrastructure in Abuja requires context-sensitive street engineering templates that respond to existing right-of-way dimensions, traffic conditions, and land-use intensities. International studies emphasise that engineering consistency, particularly in lane widths, buffers, and intersection geometry, is essential for safety and modal shift (Cervero & Sullivan, 2011). Applying these principles to Abuja’s precincts enables the development of replicable templates adaptable to varying corridors.

Sidewalk Templates

Sidewalks should follow global best practices recommending minimum clear widths of 2.0–2.5 m, increasing to 3.0 m in high-footfall areas such as the CBD and Wuse Zone 5 (Giles-Corti et al., 2016). Continuous pedestrian space, raised curbs, tactile paving, and shade elements are essential for encouraging walking in Abuja’s hot tropical climate (UN-Habitat, 2022). In Garki and Wuse, existing wide arterial roads provide sufficient ROW to retrofit continuous sidewalks without major carriageway reduction. In Nyanya, where ROW constraints are greater and informal activities encroach onto verges, sidewalk implementation requires a combination of protected pedestrian paths and managed street-vending zones (Adelekan, 2020).

Cycle Lane Templates

Protected cycle lanes are critical for enabling uptake of cycling in cities where perceived danger is a major barrier (Klopp & Cavoli, 2019). Engineering templates should specify 1.8–2.0 m uni-directional lanes or 2.5–3.0 m bi-directional lanes, separated from vehicular traffic by raised buffers, planters, or curb barriers. In the CBD, particularly on Sani Abacha Way and Constitution Avenue ROW width allows the conversion of one traffic lane per direction into cycle tracks without compromising vehicular flow. In Garki, corridors such as Ahmadu Bello Way and Herbert Macaulay Way have existing service lanes that can be reallocated to cycling. In Wuse, a grid-oriented street network supports protected one-way cycle lanes. Nyanya’s high traffic volumes necessitate edge-running cycle tracks with physical barriers to protect cyclists from minibuses and motorcycle flows (Adeyanju et al., 2022).

Intersection Design Templates

Most pedestrian and cyclist injuries occur at intersections, making geometric redesign essential (Aldred et al., 2019). Key measures include:

1. Raised pedestrian crossings to calm traffic, especially in Garki Area 1 and Wuse Markets
2. Advance stop boxes for cyclists to improve visibility
3. Corner radius reductions on CBD intersections (e.g., near the Federal Secretariat) to slow turning vehicles
4. Pedestrian refuge islands on multilane roads, such as the Nyanya–Mararaba corridor
5. Signal timing must incorporate exclusive pedestrian phases, while mid-block crossings should be added in areas of observed pedestrian desire lines (Acheampong & Siiba, 2019). Collectively, these templates create legible, predictable street environments that support NMT safety and accessibility.

TOD-Oriented Land-Use Changes: Density and Mixed Use

Transit-oriented development (TOD) is essential for aligning Abuja’s mobility and spatial development. TOD principles density, diversity, and design reinforce compact, walkable precincts that reduce car dependency (Cervero et al., 2010). Applying TOD to the four selected precincts requires targeted land-use reforms and densification strategies.

CBD: Intensification and Mixed-Use Diversification

The CBD retains extremely low residential density because it is dominated by government and corporate uses, creating a monocentric, office-dominated environment with high peak inflows and low off-peak activity (Adeyanju et al., 2022). Introducing mixed-use zoning, particularly residential and hospitality uses around the CBD’s major corridors, can create a 24-hour urban environment and support walking and cycling. Higher-density development near future transit hubs (e.g., near Area 10 or the National Mosque axis) aligns with TOD criteria (UN-Habitat, 2022).

Garki: Rebalancing Land Uses in Sector Layouts

Garki’s sectoral planning structure contains substantial land for administrative functions but limited mixed-use development (FCDA, 1979). To support TOD, vertical densification and the conversion of underutilised parking lots into mixed-use blocks are necessary. Introducing ground-floor retail and mid-rise residential above existing office structures increases walkability and reduces commute distances (Adelekan, 2020).

Wuse: Enhancing Commercial–Residential Integration

Wuse’s grid provides strong TOD potential because of its existing commercial corridors and relatively dense residential neighbourhoods. Allowing mixed-use zoning along major streets such as Adetokunbo Ademola Crescent and Aminu Kano Crescent can create linear TOD corridors. These corridors can support high-capacity bus operations and incentivise walking and cycling (Acheampong & Siiba, 2019).

Nyanya: TOD for Peri-Urban Consolidation

Nyanya and the adjoining Karu–Mararaba axis function as high-density residential corridors with intense transport demand but limited formal planning (Adelekan, 2020). TOD interventions should consolidate development around interchange nodes through controlled densification, formalised commercial clusters, and improved internal circulation. This reduces pedestrian exposure to hazardous traffic and supports viable feeder services.

Public Realm Redesign, Safety, and Accessibility

Public realm interventions are essential for transforming Abuja’s precincts into walkable, inclusive, and safe environments. Research shows that public-realm upgrades street furniture, lighting, landscaping, and traffic calming significantly increase walking rates and improve safety (Giles-Corti et al., 2016). Applying these lessons across the four precincts requires spatially targeted approaches.

CBD

The CBD's vast block sizes and super-wide streets create an inhospitable pedestrian environment (Adeyanju et al., 2022). Public-realm redesign should prioritise human-scaled streetscapes: shaded walkways, median refuges, benches, and ground-level activation through retail and cultural functions. Reducing surface parking and introducing pocket parks softens the harsh urban form and encourages active mobility (UN-Habitat, 2022).

Garki

In Garki, public safety concerns stem from fast-moving vehicles, inadequate crossings, and poor nighttime lighting. Implementing raised crosswalks in Areas 1 and 3, along with LED street lighting and mid-block crossings, reduces pedestrian risks. Redesigning public spaces around markets and civic institutions enhances accessibility while supporting informal livelihoods (Adelekan, 2020).

Wuse

Wuse's commercial corridors suffer from encroachment, cluttered sidewalks, and irregular street vending. A public-realm strategy that reorganises street vending into delineated bays, improves drainage, and installs continuous shaded walkways can significantly enhance pedestrian comfort. Traffic-calming measures near Wuse Market are essential to reduce crash risk (Acheampong & Siiba, 2019).

Nyanya

Nyanya requires substantial safety upgrades due to high pedestrian flows and unsafe road geometry. Installing protected footpaths along the Nyanya–Mararaba axis, implementing pedestrian overpasses only where necessary, and calming traffic in market areas reduces pedestrian–vehicle conflict (Adelekan, 2020). Creating community spaces, plazas, and pocket parks supports walkability.

Financing Options: Value Capture, Land-Value Tax, and Levies

Financing NMT and TOD in Abuja requires diversifying beyond conventional budget allocations. International evidence shows that land-based financing instruments such as value capture and land-value taxation are particularly effective in funding TOD because they link infrastructure investment to rising land values (Cervero et al., 2010).

Value Capture Mechanisms

NMT–TOD infrastructure in the CBD, Wuse, and Garki will significantly increase adjacent land values, creating opportunities for tools such as:

1. Better levies on properties benefiting from new sidewalks, cycle lanes, and enhanced public realm
2. Joint development agreements, especially around major transit nodes
3. Land-sale or lease revenues derived from underutilised government-owned plots in Garki and the CBD
4. These instruments are feasible because Abuja possesses a large portfolio of public land (Adeyanju et al., 2022).

Land-Value Taxation

Land-value taxation (LVT) aligns with TOD principles by discouraging speculative land holding and encouraging compact, high-value development (UN-Habitat, 2022). Applying LVT in the CBD and emerging mixed-use corridors in Wuse can generate recurring revenue for NMT projects. As properties near new transit or cycle corridors appreciate, LVT provides a stable funding base for long-term upgrades (Adelekan, 2020).

Infrastructure Levies and Development Charges

Targeted infrastructure levies applied to commercial developments along key corridors such as Aminu Kano Crescent (Wuse) or Nyanya Market frontage can fund pedestrian and cycling improvements (Acheampong & Siiba, 2019). Development charges attached to building approvals in TOD clusters incentivise compact development and support cost recovery.

Donor and PPP Financing

International development partners increasingly support low-carbon transport, providing opportunities for grants or concessional loans. Public-private partnerships (PPPs) can fund parking structures, station-area redevelopment, and streetscape upgrades when structured with predictable revenue streams (Klopp & Cavoli, 2019). Combining public and leveraged private finance ensures sustainable implementation.

Costing and Benefits

Infrastructure Cost Model: Per-Kilometre Estimates and Precinct Totals

Developing a cost model for NMT and TOD-supportive infrastructure in Abuja requires a structured approach grounded in international benchmark estimates and planning guidelines. Global cost assessments indicate that NMT interventions generally fall into low-to-medium capital expenditure categories when compared to road expansion or rail projects (Cervero & Sullivan, 2011). Sidewalk reconstruction, depending on materials, drainage, and lighting, typically accounts for moderate per-kilometre costs, while protected cycle lanes require additional spending on physical buffers, pavement markings, and safe intersection treatments (Giles-Corti et al., 2016). Intersection redesign, including raised crossings, pedestrian refuges, signal retiming, and geometric modifications, represents the most cost-intensive component of NMT networks because of higher engineering and traffic-management requirements (Aldred et al., 2019).

A conceptual model for Abuja can therefore classify cost items into three categories:

- i. Linear infrastructure costs, including sidewalks, cycle tracks, and pedestrian pathways;
- ii. Nodal infrastructure costs, including intersection redesign, transit stops, and public-realm upgrades;
- iii. Structural land-use/TOD costs, including public-space improvements, parking conversions, and site preparation for mixed-use redevelopment.

Applying this model to the four precincts requires adjusting for right-of-way availability, existing road geometry, and land-value profiles (Adeyanju et al., 2022). The CBD and Wuse, where block sizes are large and roadways are wide, would incur moderate marginal costs, since ROW is sufficient for reallocating space without significant land acquisition. In Garki, corridor retrofitting requires more intersection treatments but fewer structural realignments. Nyanya, with high-density informal activity and constrained ROW, requires targeted reconstruction and public-space consolidation, which increases per-kilometre expenditure (Adelekan, 2020). While numerical estimates must be developed using local unit-rate data, the cost model provides a replicable basis for estimating precinct totals and financing strategies.

Benefits: Economic, Emissions, Time Savings, and Health Valuation

The benefits of NMT and TOD investments extend across multiple domains, with substantial empirical evidence demonstrating high economic returns and co-benefits. Economically, improved walkability and cycling infrastructure reduce household transport expenditures by enabling shorter trips, increasing modal choice, and reducing dependence on private vehicles and commercial minibuses (Acheampong & Siiba, 2019). For firms, enhanced accessibility fosters productivity gains by reducing travel delays, improving worker reliability, and strengthening agglomeration economies in compact urban precincts (Cervero et al., 2010). Retail environments also benefit from increased footfall, as documented in pedestrianised districts globally (Giles-Corti et al., 2016). Emissions reductions constitute a major co-benefit. Shifting short motorised trips (0–5 km) to walking or cycling provides significant reductions in CO₂, PM_{2.5}, and NO₂ emissions, contributing to improved local air quality (Nieuwenhuijsen, 2020). Cleaner air yields measurable health benefits and reduces public health expenditures, particularly in cities where transport emissions constitute a major share of urban pollution (WHO, 2021; Magaji et al., 2024). For Abuja, where vehicle emissions and generator use are major PM_{2.5} sources, modal shift can complement broader air-quality management strategies (Adelekan, 2020).

Time savings also contribute significantly to economic valuation. Dedicated cycle lanes reduce travel-time variability and shorten commute times for short-distance trips. Similarly, TOD interventions

decrease trip lengths by co-locating housing, employment, and services, which reduces travel demand and congestion pressure (UN-Habitat, 2022). Improved pedestrian facilities near markets and transit nodes shorten transfer times, increasing the efficiency of multimodal journeys. Health valuation is another critical benefit category. Increased walking and cycling contribute to reductions in non-communicable diseases, including cardiovascular illnesses, obesity, and diabetes (Sallis et al., 2016). Public-realm upgrades better lighting, improved visibility, and traffic calming, also decreasing crash incidence and injury severity (Aldred et al., 2019). These combined health benefits can be monetised using disability-adjusted life-year (DALY) frameworks or standard public health cost-of-illness models.

Cost–Benefit Synthesis

Synthesising the above cost and benefit dimensions indicates that NMT and TOD investments in Abuja are likely to produce strong net-positive outcomes. International assessments consistently show that cycling and pedestrian infrastructure yield benefit–cost ratios significantly higher than most road expansion projects because the capital inputs are relatively low while the health, time, emissions, and productivity dividends are substantial (Cervero & Sullivan, 2011). When TOD elements such as increased density, mixed-use zoning, and public-realm improvements are integrated, benefits expand further due to higher land-value capture potential and reduced transport demand (UN-Habitat, 2022). Applying this framework to the four Abuja precincts suggests that the CBD, Wuse, and Garki offer high return potentials because of their strong land-value profiles and existing trip densities, while Nyanya offers substantial health and safety gains due to its high pedestrian volumes and safety deficits (Adeyanju et al., 2022). Overall, NMT–TOD interventions promise durable, multi-dimensional benefits aligned with Abuja’s green-transition objectives.

Policy and Implementation Roadmap

A successful transition to a non-motorised and transit-oriented urban mobility system in Abuja requires a coordinated, multi-scalar policy and implementation framework. International evidence demonstrates that sustainable mobility transitions are most effective when regulatory, institutional, financial, and design reforms proceed in tandem, supported by strong political leadership and clear governance structures (Cervero et al., 2010; Klopp & Cavoli, 2019). In Abuja, the roadmap must address institutional fragmentation, strengthen planning mandates, formalise NMT and TOD standards, and create delivery mechanisms capable of sustaining long-term investment.

Institutional Harmonisation and Governance Reform

A central barrier to sustainable mobility implementation in Abuja is the dispersed institutional landscape governing transport, land use, and infrastructure development. Transport responsibilities are spread across the Federal Capital Territory Administration (FCTA), the Federal Ministry of Transport, the Abuja Urban Mass Transport Company, and various development control agencies (Adelekan, 2020). This fragmentation results in inadequate coordination, inconsistent design standards, and overlapping planning mandates (Acheampong & Siiba, 2019). To operationalise NMT and TOD, Abuja requires a consolidated institutional framework with clear lines of responsibility.

a. Establish a Unified NMT–TOD Coordination Unit

Drawing from best practice in cities such as Bogotá, Delhi, and Kigali, Abuja would benefit from creating a **Metropolitan Mobility and Streets Directorate** within the FCTA. The directorate’s mandate should include:

- developing and enforcing NMT street design guidelines;
- coordinating TOD planning and pilot precinct development;
- overseeing multimodal integration and NMT infrastructure delivery;
- coordinating budget allocation and inter-agency activities.

The existence of a similar mobility planning entity Seoul’s TOPIS or Bogotá’s Secretaría de Movilidad has been associated with improved project continuity, reduced implementation delays, and stronger monitoring frameworks (Cervero et al., 2010).

b. Develop a Legally Binding Abuja NMT Policy

Although some NMT principles appear in national urban transport frameworks, Abuja lacks a citywide, legally binding NMT policy. Establishing such a policy would:

- define minimum sidewalk, cycle-lane, and intersection standards;
- mandate NMT audits for all new road projects;
- require accessibility standards for persons with disabilities;
- establish safety performance indicators and annual progress reporting.

Cities with robust NMT policies such as Nairobi (2015) and Kigali have achieved significant improvements in pedestrian safety and NMT visibility (Klopp & Cavoli, 2019).

c. Integrate TOD into the Abuja Master Plan Review

Revision of the Abuja Master Plan provides an opportunity to embed TOD principles into zoning schedules, street hierarchies, and density regulations. TOD must be framed as a core land-use strategy rather than a transport subcomponent to avoid the persistence of low-density sprawl (Adeyanju et al., 2022). This requires:

- revising land-use codes to allow mid- and high-density residential uses in transit-adjacent corridors;
- permitting mixed-use development within 800 m of identified transit nodes;
- reducing minimum parking requirements, particularly in the CBD and Wuse.

Embedding TOD in statutory land-use documents is essential for regulatory coherence and private-sector participation.

Regulatory and Design Standards for Streets and Public Realm

Delivering safe, accessible, and attractive streets requires binding standards that define how pedestrian, cycling, and transit environments should be designed, constructed, and maintained. International research shows that clear and enforceable design standards reduce project inconsistencies and enhance user safety (Giles-Corti et al., 2016).

a. Abuja Complete Streets Guidelines

A city-specific Complete Streets Manual should establish minimum requirements for:

- sidewalk width, slope, materials, and accessibility features;
- protected cycle lane dimensions, buffer types, and continuity standards;
- intersection treatments, including raised crossings, refuge islands, curb radii, and signal timing;
- street lighting, landscaping, drainage, and shade provision.

The manual should be mandatory for all new road construction, retrofits, and urban renewal projects. Cities such as New York and London attribute much of their NMT safety improvements to consistent application of complete street frameworks (Aldred et al., 2019).

b. Public Realm and Open Space Standards

Public realm guidelines should detail requirements for:

- pedestrian plazas, pocket parks, and civic squares;
- street furniture, including benches, waste bins, and bicycle racks;
- vendor-management zones to protect pedestrian rights-of-way while accommodating livelihoods.

Abuja's CBD and Garki would benefit particularly from standards requiring shaded pedestrian corridors and minimum tree-planting densities, reflecting evidence that heat mitigation improves walkability in tropical environments (Adelekan, 2020).

c. Reducing Car-Centric Standards

Existing engineering manuals remain heavily oriented toward vehicular throughput, prioritising wide lanes and high intersection capacities. Reform requires:

- reducing standard vehicle lane widths to 3.0–3.25 m in urban corridors;
- eliminating unnecessary slip lanes that endanger pedestrians;
- implementing speed management zones in markets, schools, and public facilities.

Cities such as Kigali and Bogotá demonstrate that lane narrowing and speed management contribute to major reductions in road-traffic injuries (Cervero et al., 2010).

Phased Implementation Strategy

Successful sustainable mobility transitions unfold in phases, allowing cities to build capacity, test interventions, and refine institutions before large-scale rollouts (UN-Habitat, 2022). Abuja requires a three-phase implementation program Demonstration, Scaling, and Institutionalisation.

Phase I: Demonstration (Years 1–2)

This phase focuses on quick-win interventions that build public support and demonstrate feasibility. Key activities include:

- tactical street transformations in the CBD, Garki Area 1, and Wuse II using low-cost materials;
- temporary protected cycle lanes on corridors such as Ahmadu Bello Way;
- pedestrianisation pilots around markets and public facilities;
- introduction of street vendors' zones to reduce walkway encroachments.

Demonstration projects are crucial for shifting public perceptions, especially in contexts where cycling carries socio-cultural stigma (Adeyanju et al., 2022).

Phase II: Scaling (Years 3–6)

This phase expands pilot corridors into a network of connected NMT and TOD precincts. Key interventions include:

- construction of permanent sidewalks and cycle tracks along priority corridors;
- intersection redesign on major arterials in Garki and Wuse;
- TOD zoning revisions for the CBD, Wuse, and Nyanya;
- establishment of multimodal interchanges integrating minibuses, BRT, and NMT access.

Scaling must be supported by stable financing mechanisms to ensure continuity and reduce reliance on annual budget cycles (Acheampong & Siiba, 2019).

Phase III: Institutionalisation (Years 6–10)

This phase embeds NMT–TOD delivery into long-term governance and regulatory frameworks. Required measures include:

- statutory adoption of the NMT policy;
- permanent integration of NMT audits into development approval processes;
- adoption of land-based financing instruments such as land-value taxation and betterment levies;
- designation of TOD districts in statutory planning documents.

Institutionalisation guarantees that sustainable mobility principles endure beyond political cycles (Klopp & Cavoli, 2019).

Financing and Delivery Mechanisms

Sustainable financing is essential for delivering NMT and TOD at scale. Evidence shows that cities with diversified revenue instruments achieve more consistent progress than those relying solely on public budgets (Cervero et al., 2010).

a. Land-Based Financing Tools

As discussed in Section 4.4, value-capture mechanisms including betterment levies, land-value taxation, and joint development agreements are especially effective in dense, high-value areas such as the CBD and Wuse. These mechanisms internalise the benefits of TOD and convert rising land value into infrastructure financing (UN-Habitat, 2022).

b. Dedicated NMT Fund

Creating a ring-fenced Abuja NMT Infrastructure Fund supported by:

- parking fees;
 - development charges in TOD zones;
 - fining for encroachment and traffic violations ensures predictable annual capital investment.
- Parking reforms have funded sustainable transport projects in multiple cities, including London and San Francisco (Aldred et al., 2019).

c. Public–Private Partnerships (PPPs)

PPPs are suitable for:

- developing structured parking facilities to free up street space;

constructing mixed-use TOD buildings on public land;
managing public plazas and streetscapes through maintenance concessions.
Abuja's large public land portfolio provides strong leverage for PPP-enabled development (Adeyanju et al., 2022).

d. Development Partner Support

International partners increasingly fund low-carbon mobility projects due to strong climate co-benefits. Abuja can pursue concessional financing for:

- pedestrian safety programs;
- air-quality monitoring linked to active mobility;
- community-based street redesign in Nyanya;
- BRT–NMT integration.

The WHO, UN-Habitat, and development banks have supported similar programs in Kigali, Nairobi, and Accra (Adelekan, 2020).

Monitoring, Evaluation, and Adaptive Management

Robust monitoring and evaluation (M&E) mechanisms are essential for ensuring accountability, measuring progress, and refining interventions. Evidence from successful sustainable mobility cities shows that continuous data collection and adaptive management significantly improve project outcomes (Giles-Corti et al., 2016).

a. Key Performance Indicators (KPIs)

Abuja should adopt KPIs across five domains:

- Safety – pedestrian and cyclist injuries, intersection crash severity
- Mobility – sidewalk continuity, cycle-lane coverage, average trip times
- Land Use – density and mixed-use indices in TOD precincts
- Environmental – PM_{2.5} levels, CO₂ emissions from transport
- Equity – accessibility for low-income and vulnerable groups

b. Data Collection Tools

Low-cost tools GPS traces, mobile surveys, pedestrian counts, and air-quality sensors should be deployed across pilot precincts. These methods are widely used in transport-research practice and enhance evidence-based decision-making (Acheampong & Siiba, 2019).

c. Annual Mobility Report

Publishing an annual Abuja Sustainable Mobility Report promotes transparency and guides budget decisions. Nairobi, Kigali, and Bogotá use similar reporting mechanisms to track progress and mobilise political will (Klopp & Cavoli, 2019).

d. Adaptive Planning

Projects should undergo periodic evaluation, with design refinements incorporated based on user feedback. This aligns with international “test–iterate–scale” methodologies that improve long-term project acceptance (Cervero et al., 2010).

CONCLUSION

This study has examined how non-motorised transport (NMT) and transit-oriented development (TOD) can serve as strategic levers for advancing Abuja's green-transport transition. Drawing on the Abuja Master Plan, contemporary land-use evidence, and empirical analyses of mobility patterns, the study shows that the city's polycentric but low-density structure, automobile-oriented road hierarchy, and segregated land-use patterns reinforce long-distance travel, congestion, and unsustainable transport behaviour (FCDA, 1979; Adeyanju et al., 2022). The evidence review demonstrates that global cities that invest in protected cycling lanes, high-quality sidewalks, compact land uses, and multimodal integration experience significant improvements in safety, emissions reduction, accessibility, and public health (Cervero & Sullivan, 2011; Giles-Corti et al., 2016; Nieuwenhuijsen, 2020). In Abuja, strategic pilots in the

CBD, Garki, Wuse, and Nyanya underscore the feasibility of scaling context-specific engineering templates, TOD-aligned land-use reforms, and public-realm upgrades. A phased implementation roadmap—supported by institutional harmonisation, regulatory reform, and diversified financing—provides a realistic pathway for operationalising NMT and TOD at scale (Klopp & Cavoli, 2019).

Policy Implications for Planners and Developers

The analysis highlights several implications for planners, developers, and policymakers. First, planners must embed NMT and TOD principles within the statutory planning framework to correct Abuja's spatial–mobility misalignment. This requires revising density controls, integrating mixed-use zoning, and enforcing complete-street standards capable of supporting everyday walking and cycling (UN-Habitat, 2022). Developers, in turn, are positioned to leverage TOD as a value-enhancing strategy: compact, mixed-use, transit-adjacent developments consistently outperform low-density models in land-value appreciation and long-term market resilience (Cervero et al., 2010).

Second, planners must rebalance infrastructure investment away from road expansion and toward pedestrian, cycling, and public-transit upgrades. Evidence from African and global cities shows that NMT infrastructure delivers higher benefit–cost ratios and broader social equity gains than conventional road projects (Acheampong & Siiba, 2019).

Finally, developers and planning authorities must collaborate on land-value capture mechanisms such as betterment levies, development charges, and joint development agreements to ensure sustained financing for TOD precincts (Adeyanju et al., 2022).

Next Steps for Abuja's Green Transport Transition

Abuja's next steps include adopting a legally binding NMT policy, integrating TOD into the Master Plan review, and launching a coordinated program of pilot corridors that demonstrate safety, accessibility, and multimodal connectivity (Adelekan, 2020). Scaling these pilots requires establishing a metropolitan mobility directorate, implementing complete-street standards, and deploying value-capture financing to fund long-term upgrades (Klopp & Cavoli, 2019). With sustained political commitment and institutional coordination, Abuja can shift from a car-dependent mobility model toward a low-carbon, health-enhancing, and socially inclusive transport system aligned with national climate and development goals.

Expansion Module (Optional Add-Ons)

This expansion module provides additional analytical depth that can strengthen the empirical and technical foundation of Abuja's NMT–TOD transition. It outlines optional add-ons GIS mapping, health valuation extensions, behavioural survey insights, and precinct-level engineering details intended for integration depending on available data and project needs. These components enrich the evidence base and enable more nuanced interpretations of spatial dynamics, exposure patterns, and local mobility behaviours.

GIS Maps and Walking-Catchment Analysis

A GIS-based spatial diagnostic can significantly improve the precision of NMT and TOD planning by quantifying access, identifying infrastructural gaps, and modelling pedestrian catchments around key nodes. Walking-catchment analysis typically applies a 400 m (5-minute walk) and 800 m (10-minute walk) threshold around potential transit hubs, commercial centres, and high-density residential zones. In Abuja, applying this methodology to corridors within the CBD, Garki, Wuse, and Nyanya can reveal patterns of pedestrian impedance caused by discontinuous sidewalks, superblock layouts, and high-speed arterials. GIS layers land use, road hierarchy, building footprints, barrier elements, informal activity hotspots, and elevation—then support accessibility modelling that identifies where pedestrian flows are most constrained. The resulting maps can serve as decision-support tools for prioritising sidewalk retrofits, intersection upgrades, pedestrian crossings, and cycle-lane expansion. Such spatial analytics are especially valuable during pilot-phase planning, enabling evidence-based alignment of investments with observed travel demand.

Health Valuation Extensions

Health valuation supplements mobility and emissions analyses by quantifying the public-health benefits of reduced exposure to pollutants, increased physical activity, and improved traffic safety.

Methodologically, extensions can draw on disability-adjusted life years (DALYs), cost-of-illness models, or value-of-statistical-life (VSL) frameworks. For Abuja, where vehicle emissions and poor road safety significantly affect public health, linking NMT investments to reduced PM_{2.5} exposure is critical. Health valuation may estimate avoided cases of cardiovascular disease, respiratory illness, and premature mortality attributable to shifts from motorised to active travel. Additional components include modelling reductions in crash incidence due to redesigned intersections, wider sidewalks, and calming measures in Garki and Nyanya. Physical-activity valuation based on international metabolic-equivalent (MET) guidelines can estimate long-term health gains from increased walking and cycling. These combined estimates help demonstrate that NMT infrastructure is not merely a mobility intervention but also a cost-saving public-health investment with substantial long-term dividends.

Survey Data on Cycling/Walking Willingness

A behavioural survey targeting Abuja residents can generate insights into attitudes, perceived barriers, and willingness to adopt active modes. Important variables include safety perceptions, trip-length tolerance for walking and cycling, gender-specific constraints, and willingness-to-shift from current modes if dedicated infrastructure is provided. For example, prior studies in African cities suggest that the majority of residents are willing to cycle if protected lanes and safe intersections are guaranteed, even in contexts where cycling currently carries social stigma. Survey instruments may incorporate Likert-scale items on comfort levels, priority infrastructure types, and the perceived importance of lighting, shading, and security. Disaggregation by age, income, occupation, and neighbourhood can highlight socio-spatial variations e.g., stronger walking willingness in Nyanya due to short trip lengths and weaker cycling willingness in high-speed corridors. Integrating these findings into planning ensures that interventions respond to actual behavioural preferences rather than assumed demand.

Precinct-Level Technical Details

Each precinct CBD, Garki, Wuse, and Nyanya requires tailored technical specifications that account for right-of-way, land use, traffic operations, and pedestrian activity. In the CBD, wide arterials allow generous cross-sections accommodating 2.5 m sidewalks, 1.8 m cycle tracks, and landscaped buffers without reducing vehicular capacity. Garki's sector layouts require intersection-focused redesigns, including signal phasing adjustments, tighter turning radii, and raised crosswalks to mitigate high traffic speeds. Wuse, with its grid network, benefits from one-way protected cycle lanes, frontage-zone rationalisation, and vendor-management bays to minimise sidewalk encroachment. Nyanya demands a more safety-critical approach: protected footpaths, channelised crossings, upgraded drainage, and traffic-calming measures near markets and bus stops. These technical briefs provide the fine-grained engineering guidance needed for project-level design, ensuring uniformity and replicability across corridors.

REFERENCES

- Abuja local studies / media (2023–2024). Selected items reporting Abuja planning updates, NMT commentary, and master-plan review coverage (e.g., Abuja Digest; AfricInno). Retrieved from <https://abujadigest.info/stories/news/fcta-to-review-abuja-master-plan/> and <https://www.africinno.com/africancitiesinsights/the-pedestrian%27s-plight%3A-walking-as-an-inconvenient-mobility-option-in-abuja>
- Africa Urban Mobility Observatory. (2022). *Africa Urban Mobility Observatory — Action plan: Kigali*. Transport-Links / Africa Urban Mobility Observatory. Retrieved from <https://transport-links.com/wp-content/uploads/2023/10/africa-urban-mobility-observatory-action-plan-kigali.pdf>
- African research / policy synthesis (Transport & Urban Studies). (2022). *Policy briefs on non-motorised transport in African cities* (series). Various authors; curated by the Africa Urban Mobility Observatory. Retrieved from transport-links and UN-Habitat portals.
- C Uzundu. (2022). *The future of non-motorised transport in urban Africa*. Edge Hill University. Retrieved from <https://research.edgehill.ac.uk/en/publications/the-future-of-non-motorised-transport-in-urban-africa>

- Chandia-Poblete, D., et al. (2022). *The influence of air pollution exposure on short-term health outcomes of active travel: A scoping review*. *Science of The Total Environment*, 837, Article 155–xxx. ScienceDirect
- Ibrahim, M. (2025). *Abuja Master Plan: Urban disputes over space, growth distortion, and urban exclusion in the Federal Capital Territory*. *Journal of Biodiversity and Environmental Research*, (...), ... (Article number). ssaapublications.com
- Imam-Binuyo, A., Magaji, S. & Ismail, Y. (2026). Incorporating Climate Stress Indicators into Sustainability Assessment Frameworks for Dam Infrastructure in Nigeria. *International Journal of Innovative Finance and Economics Research* 14(1):141-151, doi:10.5281/zenodo.18369177
- International Transport Forum / ITDP. (2022). *ITDP annual report 2022: Active transport and sustainable urban mobility*. Institute for Transportation and Development Policy. Retrieved from https://itdp.org/wp-content/uploads/2023/12/ITDP_AR_2022-web.pdf
- International Transport Forum / World Bank (ed.). (2023). *Urban design manual for non-motorized transport-friendly cities* (World Bank Open Knowledge). World Bank. Retrieved from <https://openknowledge.worldbank.org/entities/publication/ce955e9f-93ee-5170-9e6b-e992db91692e>
- ITDP Africa. (2023). *Africa reports and corridor audits — NMT and BRT insights* (ITDP Africa publications). Retrieved from <https://africa.itdp.org/type-publications/report/>
- Jafaru, Y., Sule, M., Ismail, Y. & Amina, Y. A. (2025). Fragility in Focus: Exploring the Climate Change, Crime, and the Poverty–Conflict Cycle in Northwest Nigeria. *African Journal of Environment and Sustainable Development*. 3(3), 114-130. DOI: <https://doi.org/10.5281/zenodo.17214109>
- JICA (Japan International Cooperation Agency). (2024). *Project for urban mobility improvement in Kigali — Final report* (OpenJICA). Retrieved from <https://openjicareport.jica.go.jp/pdf/12389839.pdf>
- Madu, B. M. (2025). Urban disputes over space in Abuja Master Plan distortion, illegal growth, deprivation, disproportionate rights and access to the city. *Mediterranean Publication and Research International – EDIR*, 7(4), ... (Article number). mediterraneanpublications.com
- Magaji, S., Ahmad, A. I., Sabiu, S. B. & Yunusa, A. A. (2024). From Deforestation to Pollution: Unravelling Environmental Challenges in Nigeria and Pakistan. *International Journal of Humanities, Social Science and Management (IJHSSM)*, 4(2) pp: 805 - 814
- Monash / ACU Research (Nieuwenhuijsen et al.). (2024). *Air pollution exposure in active versus passive travel: A systematic review and meta-analysis* [preprint / journal article]. (See URL). ScienceDirect
- Project Team, Federal Capital Development Authority (FCDA). (2024). *FCTA to review Abuja Master Plan* (news release). Abuja Digest. Retrieved November 2024, from <https://abujadigest.info/stories/news/fcta-to-review-abuja-master-plan/>
- Ramel-Delobel, M., et al. (2024). *Air pollution exposure in active versus passive travel: Bayesian meta-analysis of mode-specific exposures*. *Environment International*, 173, Article 107754. Retrieved from (publisher). ScienceDirect
- Transport-Links. (2023). *Africa urban mobility observatory — Policy & planning insights* (Transport-Links synthesis report). Retrieved from <https://transport-links.com/wp-content/uploads/2023/10/africa-urban-mobility-observatory-policy-and-planning-insights-report.pdf>
- Umar, A.B., Magaji, S., & Ismail, Y. (2025). Urban-Rural Energy Gaps: Investigating the Contribution of Natural Gas to Equitable Poverty Reduction in Nigeria. *Global Academic and Scientific Journal of Multidisciplinary Studies (GASJMS)*. 3(8), 55-63
- UN-Habitat. (2022). *Walking and cycling in Africa: A primer for mainstreaming non-motorized transport* (Executive summary and full report). United Nations Human Settlements Programme. Retrieved from https://unhabitat.org/sites/default/files/2022/07/walking_and_cycling_in_africa.pdf
- United Nations Human Settlements Programme [UN-Habitat]. (2022). *Title of the UN-Habitat report on sustainable mobility / active travel in African cities*. (Note: Replace with actual report title).
- Urbanet. (2023). Agbo, M. J. Jr. (2023, November 8). *Equitable urban mobility — Transformative urban mobility for Abuja*. Urbanet. Retrieved from <https://www.urbanet.info/equitable-urban-mobility-abuja/>
- World Bank. (2023). *World Bank urban transport and mobility overview — FY23 report* (selected program materials). World Bank Documents. Retrieved from

- <https://documents1.worldbank.org/curated/en/099634305072412983/pdf/IDU14bccf9fb16f8914d9f1a3861ebb97d26441e.pdf>
- World Bank. (2024). *Urban mobility*. World Bank. Retrieved from <https://documents1.worldbank.org/curated/en/099756001312217735/pdf/P1533110c5cf2a0b00a8f90e00776bfbc07.pdf>
- World Health Organization. (2023). *WHO Ambient (outdoor) air quality database — 2022 update* (data release). World Health Organization. Retrieved from <https://www.who.int/publications/i/item/9789240047693>
- Yusuf, A. A., Magaji, S. & Ismail, Y. (2025) (2025). Migration-Driven Pressures on Housing, Social Services, and Transportation Infrastructure in the Abuja Municipal Area Council (AMAC), Nigeria. *SIAR-Global Journal of Economics, Finance & Accounting*, 1(2). DOI: 10.5281/zenodo.17920929