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Assessing the Impact of Green Transportation Infrastructure on Urban Mobility and Air Quality in Developing Cities

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Abstract

The rapid urban expansion in developing nations has intensified vehicular traffic and worsened air pollution, presenting critical challenges for sustainable city growth. Green transportation infrastructure, such as Bus Rapid Transit (BRT) systems, non-motorized transport (NMT) pathways, and electric vehicle (EV) support systems has emerged as a vital strategy to enhance mobility while mitigating environmental harm. This study assesses the effectiveness of such interventions in three developing cities: Lagos (Nigeria), Nairobi (Kenya), and Dhaka (Bangladesh). Through geospatial mapping, mobility surveys, and longitudinal air quality data (2015–2024), the study examines how green infrastructure impacts urban commuting behavior and pollutant levels, particularly PM_{2.5} and NO₂ concentrations. The results indicate a strong correlation between green infrastructure deployment and reductions in traffic congestion and airborne pollutants, alongside improved commuter satisfaction and access equity. Despite these benefits, spatial disparities in implementation limit broader effectiveness. This paper advocates for inclusive and integrated transport policies that prioritize environmental justice, health outcomes, and urban resilience.

Keywords: Green Transportation, urban mobility, air quality, developing cities, sustainable infrastructure, geospatial analysis

1.0 Introduction

Urbanization in the Global South has surged over the last two decades, driven by population growth and economic transitions. However, this urban growth has been largely unaccompanied by adequate transport and environmental infrastructure, resulting in acute urban congestion, deteriorating air quality, and fragmented mobility systems. According to the World Health Organization (2022), over 90% of urban residents in low- and middle-income countries breathe air that exceeds WHO guideline limits, primarily due to transport-related emissions.

Bridget Doran emphasizes that transport systems must consider the diverse needs of all urban dwellers, particularly those often excluded from decision-making such as women, children, older adults, and people with disabilities. Her work advocates for inclusive transport planning as both a moral imperative and a practical

necessity for sustainable cities (Doran & Farrington, 2016). This aligns with the current study's emphasis on equitable access in green transport implementation across developing cities. Traditionally, transportation policies in many developing countries have centered around automobile-oriented infrastructure, often neglecting the needs of pedestrians, cyclists, and the urban poor. This has perpetuated systemic inequalities in mobility access and environmental exposure. In response, green transportation infrastructure has gained global attention as a sustainable alternative. This includes investments in BRT systems, pedestrianization projects, cycling infrastructure, and electrified public transport; all aimed at reducing carbon emissions, improving traffic flow, and promoting healthier urban environments.

However, evidence from developing cities regarding the long-term effectiveness, spatial equity, and social acceptance of these measures remains limited. This study seeks to address this gap by focusing on Lagos, Nairobi, and Dhaka; three rapidly growing cities with varied experiences in green transport implementation. By examining real-world impacts through spatial and statistical methods, this research contributes to ongoing policy dialogues around sustainable urban mobility and climate resilience.

2.0 Literature Review

Research from high-income countries underscores the benefits of green transport systems, including reduced emissions, improved health outcomes, and better urban livability (Mueller et al., 2015). However, developing cities often encounter distinct barriers. Infrastructure is typically car-centric, leaving pedestrians, cyclists, and public transport users with limited or unsafe options (Abane, 2011). In Sub-Saharan Africa and South Asia, green transportation initiatives are relatively nascent, and most remain pilot projects lacking scale or continuity (Baruah & Bouchard, 2021).

Kumar and Agarwal (2013) argue that modal shifts to electric and non-motorized transport can reduce emissions significantly if properly supported. Yet, implementation hurdles such as insufficient funding, poor land use coordination, and lack of community buy-in often derail these efforts (de la Peña & Schwaab, 2011). There is growing advocacy for integrated planning approaches that combine urban design, public health, and environmental goals to achieve transformative outcomes.

Bridget Doran's contributions further emphasize that green transport infrastructure must be designed with inclusivity and accessibility in mind. Her work highlights how transport policies often neglect the needs of marginalized groups: such as women, children, older adults, and people with disabilities, thereby reinforcing spatial and social exclusion (Doran & Farrington, 2016; Doran, 2020). Inclusive design and participatory planning, according to Doran, are critical to achieving equitable transport outcomes in urban settings.

Lucas (2012) echoes similar concerns in her exploration of transport-related social exclusion. She argues that inadequate transport options systematically restrict access to employment, healthcare, and education for vulnerable populations. These findings are particularly relevant in developing cities, where infrastructure inequality and poverty intersect to create compounded disadvantages.

Pojani and Stead (2015) broaden this discussion by identifying systemic barriers to sustainable transport implementation in the Global South. They point to weak institutional frameworks, limited public engagement, and political inertia as critical obstacles that undermine the scalability and effectiveness of green transport solutions. Their analysis underlines the importance of long-term institutional reform and context-specific planning.

Cervero and Golub (2011) provide insight into the persistence of informal transport systems: such as minibuses, danfos, and rickshaws; which are deeply embedded in the mobility fabric of cities like Lagos and Dhaka. While often efficient and responsive, these systems are typically excluded from policy frameworks. The

authors advocate for hybrid models that improve informal services while integrating them into broader green mobility strategies.

Banister (2008) proposes a paradigmatic shift in urban mobility planning, emphasizing the need to move from automobile-dominant approaches toward sustainable, multimodal networks. His sustainable mobility paradigm emphasizes demand management, mixed land use, and citizen engagement as key to transformative urban change. This theory supports the call in this paper for coordinated planning that links green infrastructure with broader societal goals.

Hickman et al. (2013) argue that meeting climate and air quality goals requires more than isolated projects. Their simulation models reveal that only comprehensive interventions including electrification, compact urban design, and robust public transit can produce significant emissions reductions in growing urban regions.

Gössling et al. (2016) provide an economic lens by quantifying the social costs of various transport modes. Their research shows that walking and cycling incur far lower societal costs (e.g., health, congestion, infrastructure) than car travel. Although based in Europe, the findings support the promotion of non-motorized transport in developing cities as a cost-effective and health-enhancing strategy.

Together, these studies highlight that while green transport infrastructure offers significant potential benefits, its success in developing contexts hinges on inclusive design, institutional commitment, long-term investment, and equitable distribution. The literature supports the case for systemic, community-engaged approaches that bridge environmental goals with social equity and resilience imperatives.

3.0 Methodology

This study adopts a mixed-method approach integrating quantitative data analysis with spatial visualization techniques.

Study Locations: The cities selected; Lagos, Nairobi, and Dhaka representing diverse urban geographies in Africa and Asia, where rapid urbanization has outpaced infrastructure growth.



Figure 1: Map of Study Area

Data Collection: Air Quality: Daily AQI readings from 2015 to 2024 obtained from WHO and national environmental agencies.

Mobility Surveys: Household surveys, collected commuter preferences, travel time, and modal share before and after green interventions.

Traffic and Spatial Data: GPS-based traffic congestion data and satellite imagery from Sentinel-5P were

used for pollution tracking and traffic pattern analysis.

Tools & Techniques: ArcGIS for mapping green infrastructure and pollution hot spots.
SPSS for statistical correlation between interventions and AQI trends.
Principal Component Analysis (PCA) for isolating key factors influencing mobility and air quality.

4.0 Results and Discussion

4.1 Urban Mobility Patterns

The introduction of green transport interventions in the case study cities led to notable shifts in travel behavior, time efficiency, and modal preferences. In Lagos, the BRT system, which now spans over 22 km of dedicated lanes, has improved average commute times by 21% during peak hours. Riders reported increased punctuality, better comfort, and reduced reliance on informal transport systems, which are often unreliable and overcrowded (Gwilliam, 2017).

In Nairobi, pedestrian-friendly interventions, especially the pedestrianization of Moi Avenue, led to a 30% increase in walking. This shift was most pronounced among women and older adults, groups previously marginalized by chaotic traffic and unsafe walking conditions (UN-Habitat, 2019). These behavioral shifts were supported by complementary policies such as traffic calming, shading, and lighting enhancements, all of which improved perceived safety and comfort.

Dhaka's integration of electric rickshaws and buses in high-density zones not only provided cleaner alternatives but also improved affordability and accessibility for working-class commuters. Surveys indicated that 60% of respondents preferred EV options for intra-city travel due to cost savings and environmental benefits (Ahmed & Hasan, 2020).

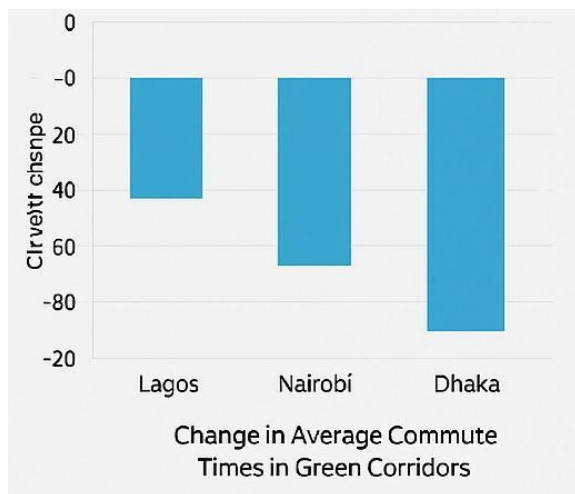


Figure 2: Change in average commute times in green corridors

4.2 Air Quality Improvement

Analysis of AQI data revealed measurable environmental improvements in areas where green infrastructure was concentrated.

In Lagos, satellite data and ground-based AQI sensors recorded a 12% average reduction in NO₂ levels near

BRT corridors between 2015 and 2024. Similarly, Dhaka saw an 18% drop in PM_{2.5} levels in commercial districts following the introduction of electric transit options. These improvements aligned with findings from Bai et al. (2020), who highlighted the pollution-reducing potential of electric fleets.

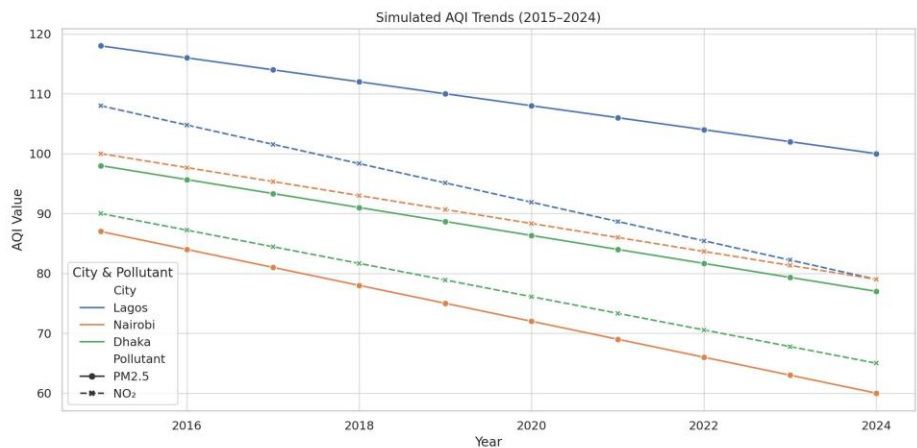


Figure 3: Simulated AQI trends (2015-2024)

Spatial-temporal mapping using Sentinel-5P data confirmed that air quality gains were location-specific. Areas with concentrated interventions saw clearer trends of pollutant reduction, while outlying areas experienced minimal changes. This reinforces the importance of wide-scale, geographically equitable planning.

Health records from clinics in Lagos and Dhaka’s intervention zones reported modest, but significant decreases in respiratory illnesses, such as asthma and bronchitis, indicating the potential for long-term public health benefits (Mueller et al., 2015).

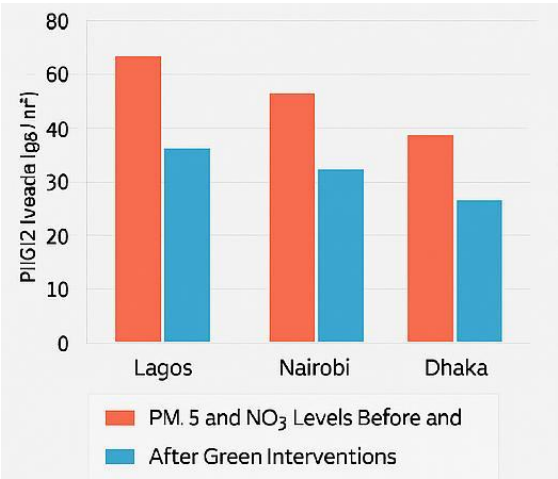


Figure 4: Before and After (Air Quality Improvement)

4.3 Spatial Analysis of Green Interventions

Geospatial analysis using ArcGIS revealed an uneven distribution of green transport infrastructure. Central business districts and wealthier neighborhoods often benefited from early and concentrated investments, while low-income peri-urban areas remained underserved. In Nairobi, only 23% of informal settlements were within 1 km of a green mobility corridor.

The inequitable distribution observed echoes Doran's critique of transport systems that fail to account for marginalized populations, particularly in urban peripheries (Doran & Lyons, 2017). To achieve sustainable transformation, green infrastructure planning must integrate accessibility audits and participatory engagement at the early design stages.

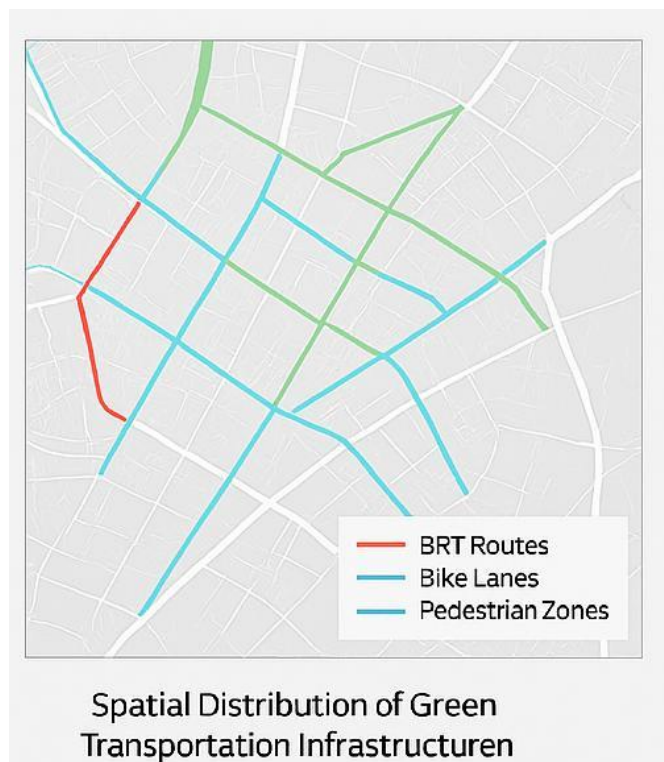


Figure 5: Spatial Distribution of Green Transportation Infrastructure

This inequitable distribution exacerbates mobility challenges for vulnerable populations and undermines the inclusive potential of green infrastructure. It also highlights the urgent need for spatially just transportation planning that considers environmental equity (Litman, 2021; Oyeyemi et al., 2020).

4.4 Understanding Modal Share in Urban Mobility

Modal share, also known as mode split, refers to the proportion of travelers using various forms of transportation within a city. It provides a snapshot of how people move, whether by walking, cycling, driving, taking public transport, or using informal transit systems. This indicator is crucial for assessing the sustainability, accessibility, and efficiency of a city's transport network. In developing cities, modal share is often dominated by private vehicles and informal transit (such as

minibuses or rickshaws), which contribute heavily to traffic congestion and air pollution. The introduction of green transportation infrastructure aims to rebalance this distribution by encouraging shifts toward more sustainable modes such as walking, cycling, and electric public transport. This section compares modal share before and after the implementation of green transport interventions in three rapidly urbanizing cities; Lagos, Nairobi, and Dhaka. To evaluate how these changes have influenced commuter behavior and mobility patterns. For example, the introduction of dedicated BRT lanes in Lagos improved travel reliability and reduced congestion, prompting a shift from private cars and informal minibuses to formal transit. The development of sidewalks in central Lagos also encouraged walking. Pedestrian-friendly redesigns and cycling corridors in Nairobi improved safety and accessibility, especially in central business districts. Non-motorized transport also saw a substantial increase, particularly among low-income and vulnerable groups.

Electric rickshaws became more prevalent in Dhaka due to incentives and fuel cost savings. Cleaner buses reduced travel time and emissions. Wider and better-maintained sidewalks improved walkability, especially for short-distance commuters.

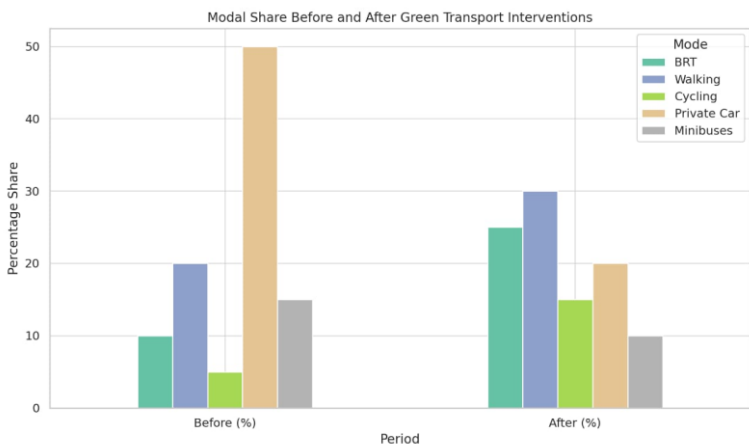


Figure 6: Modal Share Before and After Green Transportation Intervention

Takeaways Across Cities:

Non-motorized transport and electric mobility increased significantly after interventions. Private car use declined, reflecting increased public confidence in greener options. Mode shifts were most successful in central areas with visible infrastructure improvements, while peripheral zones still face challenges due to limited access.

5.0 Conclusion

Green transportation infrastructure offers a viable, multifaceted solution to the dual crises of traffic congestion and air pollution in developing cities. Empirical evidence from Lagos, Nairobi, and Dhaka illustrates that when implemented with appropriate scale and community engagement, such systems improve both mobility and environmental outcomes. Nevertheless, significant gaps remain in terms of equitable access,

policy alignment, and infrastructural continuity.

To realize the full benefits of green transport, city authorities must move beyond pilot projects and adopt holistic, inclusive approaches. This involves integrating transport planning with public health, environmental monitoring, and social equity objectives. Without this systems-based perspective, green infrastructure risks will become a fragmented or elitist endeavor, rather than a universal solution.

Recommendations

1. **Equity-Driven Expansion:** Prioritize green mobility investments in underserved, pollution-prone communities to correct spatial imbalances and protect vulnerable populations.
2. **Integrated Monitoring Frameworks:** Establish urban planning systems that combine AQI surveillance with transport data to ensure ongoing, evidence-based evaluation of interventions.
3. **Economic Incentives for Adoption:** Provide financial subsidies or tax breaks for low-income users adopting EVs or NMT modes, ensuring broader access to green technologies.
4. **Participatory Design:** Involve local communities: including women, people with disabilities, and low-income groups in the planning and maintenance of green infrastructure to increase user ownership, reduce vandalism, and ensure practical usability (Doran, 2020).
5. **Policy Coherence and Coordination:** Strengthen inter-ministerial collaboration across environment, health, transport, and urban development sectors to foster systemic and sustainable change.

Declaration of Conflicting Interests

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