

Building a Sustainable City in Lagos: Insight from the Transport Initiatives from Freiburg and London

T.K. Olaniyi, A.J. Ajayi

Glasgow Caledonian University, United Kingdom

Abstract

In this paper, we present the development of a framework for achieving sustainability in the Lagos transportation sector through a study of policies and measures that have been adopted in Freiburg and London. Current population growth and urbanisation in Lagos have put a great deal of strain on transport infrastructure, which has sparked numerous studies into sustainable solutions. Various authors have expressed issues on congestion causes, its environmental and economic impact, and mitigation measures. Road transport has been identified to contribute 30% of the air pollution concentration in Lagos and high mortality rate. This study provides measures to combat the Lagos transport menace while also serving as a model tool for policymakers to achieve sustainability in other Global South cities. A comparative study of Lagos with other sustainable cities was carried out to determine the best practice for achieving sustainability. Future work will include the collection of primary data when developing sustainability measures to ensure inclusiveness and adoption by the public.

1. Introduction

Human mobility, or movement, plays a crucial role in the expansion and development of cities around the world since it influences socioeconomic activities and a nation's transport infrastructure is directly related to its economic growth [1]. One of the issues faced by cities globally especially in the Global South is traffic congestion, which leads to unexpected travel times, higher fuel consumption, as well as man-hours and financial losses [2]. Many people contend that there isn't a single, generally agreed-upon definition of traffic congestion. Operational and user views are linked to the rationale behind this. Reflecting on this perspective, the [3] defined congestion as the imbalance between the number of vehicles entering and leaving a specific area. It is exacerbated by regular and irregular reductions in service quality, which manifest as longer travel times, more variations in travel times, and interrupted travel. [4] reported that the cost of traffic congestion in the

United States comprised 482 million hours wasted due to driver delays, 87,606 crashes in work zones, 1,200 fatalities, 37,476 injuries, and over \$6.5 billion lost in time. Vehicle ownership growth rates are rising between 15 and 20 percent annually in many cities due to rapid urbanisation combined with a rise in the rate of vehicle ownership and use [2]. About 80 to 90% of the ambient levels of carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NOx), as well as a significant amount of particulate matter, are caused by incomplete combustion products from vehicular engines operating in highly congested street traffic. These pollutants pose serious risks to human health and natural resources [5].

Lagos is Africa's second-largest city, after Kinshasa, the Democratic Republic of the Congo, and one of the world's fastest-growing cities, with a population of over 15 million and a current growth rate of 3.6% (see Figure 1).

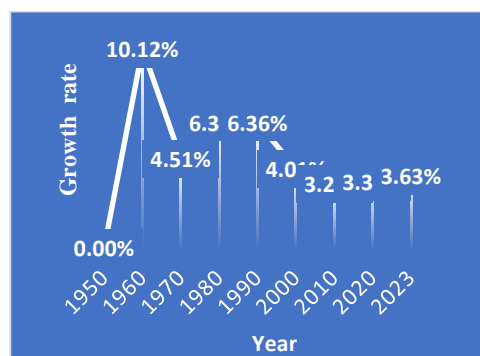


Figure 1. Lagos Population Growth Rate 1955 - 2023 [7]

Lagos was Nigeria's seat of government until December 1991, when the federal government's seat was relocated to Abuja due to various challenges, including traffic congestion, overpopulation, and a lack of space for expansion [6]. Lagos's extremely high population, as well as the commercial assets of Nigeria, have persisted in putting a strain on its infrastructure, including transportation facilities. With an average land coverage of nearly 0.4% of the total Nigerian land area, Lagos, for example,

accommodates approximately 25% of total country motor traffic [2].

Congestion in Lagos is classified as either recurrent or non-recurrent. Recurrent gridlock is caused by factors associated with population growth, urbanisation, and the associated increase in private car ownership and use. Non-recurring congestion, on the other hand, is associated with random or distinct conditions, such as traffic events (ranging from disabled vehicles to accident fatalities), work zones that slow traffic, climate, and unusual events [8]. Improper land use planning arising from rapid urbanisation constitutes another congestion problem in Lagos. The concentration of certain specialised activities, such as workplaces in some areas and apartment buildings and leisure facilities in other areas, often far from each other, causes crisscrossing movements that exacerbate congestion issues. Regular vehicle breakdowns and motor vehicle crashes are another important trend contributing to Lagos congestion, as most vehicles on the roads are fairly used vehicles known as "tokunbo" imported from the Global North. The repair culture is also very poor, with incompetent personnel for repair and part replacement, thereby increasing the risk of vehicles breaking down during operation [9].



Figure 2. Dominant Public Transport in Lagos [9]

As a result of the ineffectiveness of the public transportation system supplied by the government (see Figure 2), the public transportation sector has become an open market, attracting over half of Lagosians with personal vehicles to register with the Bolt Firm, which is gaining control of emerging markets, thereby contributing to traffic issues, and harming the state's public transit system [10]. Lagos was regarded as the only global megacity without a functionally well-organised public transport system before the introduction of Lagos BRT [11]. In Lagos, vehicular transportation is linked to air pollutants and noise. Carbon monoxide, hydrocarbons, sulphur particles, and nitrogen emissions from vehicle exhaust systems are extremely dangerous to people and the environment because they lead to cardiovascular disease, lung cancer, and breathing difficulties,

thereby militating against economic growth through sick days off work and a high mortality rate [12]. Noise from vehicle horns, malfunctioning vehicle engines, and motorists calling their next destination all make a significant contribution to an unpleasant environment and the city's unsustainable status. Many Lagosians experience mental stress as a result of traffic congestion since they must be vigilant to avoid being involved in a collision. Driving for hours on end and looking left, right, and centre raises stress levels, which triggers the production of stress hormones in our bodies. Traffic-related Road rage has grown to be a serious societal issue in the city, leading to attacks on other drivers and, in severe cases, fatalities [13]. Hence, this paper presents the development of a framework for achieving sustainability in Lagos transport through a comparative study of sustainable cities while also proposing the priority projects for the first phase of action.

2. Lagos in Relation to Sustainability

Lagos is referred to as a metropolis that is "on an uncertain trajectory, which differs from recognised patterns of capitalist urbanisation because the city is growing rapidly in a context of economic stagnation" [14]. The colonial state apparatus and its postcolonial successors were unable to develop a fully operational metropolis through investments in the built environment or the creation of cohesive technology networks. Furthermore, enormous capital flows that might have been used to fund social and physical development were instead consumed by corrupt political and military leaders working with Western financial agents [15].

The problems of intra-urban traffic in Lagos, Nigeria, studied by [16], found that 57% of commuters and motorists spend between 30 and 60 minutes on the road due to traffic congestion, with the worst traffic congestion occurring on Mondays with overdependence on the road compared to other transport modes. This agrees with the findings of the [17] study, which identified traffic congestion as a forcefully acceptable excuse for workers being late to work in Lagos metropolis. They further identified indiscriminate parking, roadside trading, flooding, the existence of potholes, vehicle breakdowns, and the absence of traffic lights at some road intersections as the major causes of traffic congestion, while also stressing the need for improved working conditions for the staff of the Lagos State Traffic Management Authority (LASTMA), established to solve congestion problems in Lagos. This is further supported by [18] findings on the identification of the causes of congestion on some selected routes in Lagos Metropolis through questionnaire administration, which concluded that the traffic situation in Lagos

Metropolis is worrisome, especially during morning and evening peak periods.

The Environmental Protection Agency [19] estimates that 14% of greenhouse gas emissions worldwide are caused by transportation. The main source of greenhouse gas emissions is the use of fossil fuels in various forms of transportation. Most of the world's transportation energy (95%) is derived from fuels derived from petroleum, specifically gasoline and diesel. About 11,200 premature deaths were caused in 2018 by ambient air pollution, with West Africa having the highest rate. Heart disease, lung cancer, and chronic obstructive pulmonary disease were the leading causes of mortality for adults, but children under five were the most impacted, accounting for 60% of all deaths. The primary source of ambient air pollution in Lagos is road transport, with every kilometre of road being congested by 227 vehicles every day. Most cars and trucks are more than 15 years old, have outdated pollution control systems, and burn fuel with sulphur levels 200 times higher than those allowed by U.S. guidelines for diesel. In 2018, the health problems and early mortality brought on by ambient air pollution cost £1.57 billion, or 2.1% of Lagos State's GDP [20]. [21] on the sources of ambient PM_{2.5} exposure in 96 global cities identified that road transport is thought to be responsible for 30% of the PM_{2.5} (particulate matter) air pollution concentrations in Lagos (Figure 3).

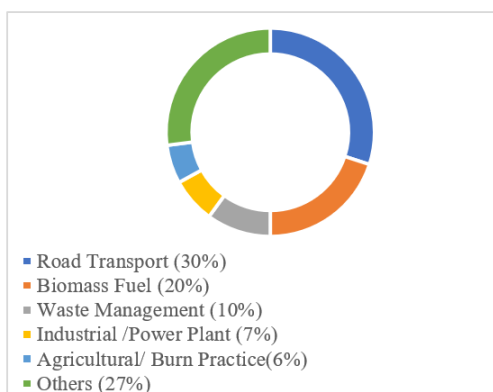


Figure 3. Lagos' PM_{2.5} Air Pollution Concentrations [21], [25]

The high sulphur content in imported diesel and petrol (3,000 ppm in diesel and 1,000 ppm in petrol) and the high vehicle density (227 vehicles/km/day) are the causes of this, as are the use of outdated emission technologies (the majority of cars are older than 15 years) and the city's limited transit options are far less than in other megacities [22].

In proposing a sustainable approach to Lagos traffic issues, [23], through the review of the Lagos state non-motorised transport policy and its impact, identified the need for strategic decisions and policies

as the measure of achieving sustainability in Lagos. They further stress the need for policy alignment with the principle of urban mobility, where cycling, walking, and public mass transit are effectively operational while opening other modes of transportation in the state. As a result of the inefficiency of the existing planning strategy in Lagos, [24] highlighted smart infrastructure approaches that concentrate on the socioeconomic position of the population, the environment, and the basic amenities and services as a means of attaining sustainable development.

3. Sustainability in Freiburg Transport

Freiburg is the economic, cultural, and political centre of the Black Forest region in southwestern Germany, with a population of 220,000 people. The Black Forest region has 615,000 inhabitants and is only about an hour's drive both from Switzerland and France [26]. The economy is centred on the tourist industry, university study and research, government and church administrative structures, and a diverse range of services to adjoining districts. Approximately three million tourists visit the city annually. The rate of motorised vehicles has been dwindling since 1970, and good policies have been implemented in contrast to the rest of Germany [26].

With respect to population growth, rising incomes, and a thriving economy, Freiburg's transportation system is considered sustainable because it combines 68% of trips by mass transit, biking, and walking. As a result, CO₂ emissions per capita are low, social equity is increased, traffic fatalities are reduced, and the profitability of public transportation systems is improved [27]. Between 1990 and 2006, Freiburg's per capita vehicle km of use decreased by 7% on all roads and by 13% on residential roads. The city's per capita CO₂ emissions also decreased by 13.4%, reaching a level that is 89% of the German average. Because Freiburg is easier to get around by public transportation, bicycle, and walking, travel is currently safer than it is in Germany as a whole, which furthers stress social equity [26].

According to [28] analysis of the transport options for new communities within the city limits, the creation of regional train connections serving the expanding towns and villages in the region, and the standard of non-motorised traffic in Freiburg city centre, urban growth can coexist with sustainability and be used to improve the modal split through effective coordination of urban development and transport policies. The success of policies in Freiburg was not limited to their implementation in stages by prioritising projects that one neighbourhood agreed upon first, thereby encouraging their adoption in other areas within the city. This is further supported by extraordinary and extensive citizen engagement with effective implementation of environmental policies

through a consensual view on climate issues across parties [28].

In order to promote sustainable transport in Freiburg, [29] identified the introduction of a low-cost monthly ticket known as the "urban environmental protection ticket," which later became a regional ticket. This attracted about 86% of all journeys made by the owners of monthly or annual tickets to public transport in Freiburg. In addition, they identified land use policies, such as the better use of urban areas with investments in brownfields, the functional mix of neighbourhoods, and the expansion of the tram network, the creation of bicycle infrastructure, and the increase of walkability. This aligns with [28] identification of "eco mobility," consisting of walking, cycling, public transport, and car sharing, as a key policy in meeting the demand for transportation arising from a growing population. [28] further emphasised public transport as the most essential element of achieving eco-mobility success while also stressing the need for integrating urban planning and modern transport systems to achieve sustainability. Since 1983, the light rail (tram) line, which provides 70% of the local transport trip, has been constantly improved, and most jobs are now within commuting distance (300 m) of a rail stop.

The timetables are fully integrated into the Freiburg public transportation system and are displayed digitally at bus and light rail stops and stations. Traffic signal priority, which automatically turns the light green for advancing buses and light rails at key junctures, and a unified ticketing system are also integrated [26]. Despite the rapid population expansion, rising earnings, and thriving economy, there has been a trend away from car use and towards more sustainability in Freiburg. Freiburg's population grew 17% faster between 1990 and 2007 than the German national average (vs. less than 3%). Between 1996 and 2005, employment in Freiburg increased at a rate that was three times that of the rest of Germany, and per-capita income increased by 29%, thereby making Freiburg Germany's leader in the green industry. The changes in Freiburg's transport and land-use regulations were made possible by its economic success and broad political support for sustainability [30].

4. Sustainability in London Transport

The population of London, the capital city of England, has increased from 8.6 million in 2015 due to immigration from the European Union and low levels of outmigration to other parts of the United Kingdom. Despite predictions that London's population will increase by nearly 10 million by 2041, the city has experienced sustained population growth [31]. With an increase in job growth between 2011 and 2016 following the 2008 stock market crisis and ensuing recession, employment has been the main

factor causing a rise in travel needs in London. Despite an increase in population, there has been an absolute decrease in the average amount of driving in London, from a peak of 50% of all trips in 1990 to 36% today [32].

The issues of traffic congestion, air pollution, and sustainable mobility have been addressed through the implementation of various policies in London. Basically, the carrots and sticks strategy has been effective in making London's transportation system sustainable. Due to London's limited road capacity, the "stick" approach entails imposing a congestion fee on private automobile owners from 7 a.m. to 6:30 p.m. in the city's central area, while the "carrot" approach focuses on: improved cycle lanes, which have increased cycling in London by over 130% since 2006; increased use of public transportation (rail and bus systems); promotion of walking-based travel; and better land use planning, which involves reallocating road space to support active and public transportation modes [31]. Even though the percentage of walks in London has not changed since 2001, the Travel in London Report shows that the number of walk-all-the-way walks increased by 9.3% in London between 2008 and 2014. Once more, there are regional differences in walking trends. Walking makes up 78% of all trips in Central London, 47% of trips in Inner London, and roughly 35% of journeys in Outer London [33].

The reduction of environmental emissions per capita in London has been largely attributed to the improved efficiency of the city's transport system. Other alternatives to driving and owning a car including ridesharing, bike-sharing, and car-sharing programmes is rising. Since their inclusion in the London transport strategy in 2003, car sharing, i.e., car clubs in the UK, has grown to become one of the biggest markets in Europe. Car sharing has been considered to play an enabling role in achieving the mayor's target of reducing car use and car ownership in London [33]. Using road traffic estimates from 1994 to 2012, cordon counts, and vehicle speed data, along with interviews with professionals in the freight industry, [34] assessments of the effects of the two sustainability policies currently in place in London on freight traffic concluded that freight traffic increased throughout London but decreased in the central congestion charge zone, while the low emissions zone was effective at spurring vehicle replacement.

[35] emphasise the necessity of using other policy instruments, such as physical, soft, and knowledge-based ones, in addition to taxes and permits to ensure sustainability in transport. In gathering data on travel habits and pro-environmental behaviour before and after the implementation of a trial congestion charging policy in Stockholm, [36] surveyed randomly selected car owners in the city and found that the policy not only directly reduces traffic congestion but also indirectly "spills over" to affect pro-environmental

behaviours in non-transportation situations, especially in resource management.

5. Methodology

The comparative study methodology was used in comparing Lagos to Freiburg and London to determine the differences, similarities, and best practices that could be adopted by Lagos in achieving sustainability in the transport sector. The cities were compared in terms of population, policies, transport infrastructure, and traffic congestion. The study uses secondary data available from existing literature, academic papers, and databases to identify trends, similarities, and differences in the cities.

6. Findings

6.1. Population

There is an increasing need for effective transport infrastructure as cities grow and populations rise, putting strain on the existing infrastructure and having a negative impact on the environment. Therefore, balancing this need for a growing population with the necessity for sustainable, accessible, and efficient transportation infrastructure is a critical issue for policymakers across the world.

The comparison of London and Freiburg, with populations of over 9,000,000 and 220,000 people, respectively, to Lagos, with over 15 million people, indicates that all cities have similarities and differences in terms of people. From Figure 4, both London and Lagos have witnessed a rapid growth rate in terms of population, and this has created pressure on the existing facilities as well as complicated the problems of updating new transport infrastructure. By 2050, it is anticipated that London will have 6.3 million employees, up from the current 5.4 million. London's growing global prominence and globally focused economy are major contributors to the city's population growth. However, the London transport system has seen significant investment from Transport for London, Network Rail Boroughs, and other parties, and this investment is still ongoing.

Lagos is home to more than 60% of all non-oil businesses in Nigeria, making up more than 70% of Nigeria's total industrial output and the most industrialised metropolis in the Economic Community of West African States (ECOWAS) sub-region. And given the tight connection between industrial activity and transportation, particularly freight transportation, an ineffective transport system manifested in overdependence on roads in Lagos in the usage of trucks and heavy-duty vehicles to convey manufactured goods from industries and raw materials for production to and from industrial complexes. This is complicated by the unavailability of land for expansion, corruption in government, and poor transportation plans in guiding and preparing for

the rapid growth rate experienced in the transport sector. With the current growth rate, there is a need for the adoption of policies from sustainable cities around the world to provide solutions to the current transport challenges.



Figure 4. Population Growth Data for The Three Cities [3]

6.2. Transport Infrastructure

Transportation infrastructure refers to the physical structures that facilitate the flow of people, products, and services both within and between geographical areas. It encompasses a wide range of components that are necessary for community cohesion and economic development, such as public transportation systems, ports, highways, railroads, bridges, and roadways. Economic success and regional growth are stimulated by effective and well-planned transportation infrastructure. Strong infrastructure influences land use, shapes urban and rural landscapes, and serves as a basis for sustainable development in addition to improving accessibility.

London and Freiburg have an integrated transport system that offers residents, commuters, and visitors a range of options for getting around the city efficiently and sustainably. Their transport infrastructure continues to evolve and expand to meet the growing demand and support sustainable transport goals. Transport for London (TfL), Network Rail Boroughs, and others have made, and are still making, significant investments in the London system. The TfL Business Plan, which delivers many of the transport requirements stated in the Mayor's Transport Strategy, which looks to 2031, lays out TfL's spending projections for the following ten years. However, initiatives like Crossrail and the Tube Upgrade Programme are only the tip of the iceberg in terms of what would be required. As part of the extensive "Croydon 2020" regeneration plan, which saw the return of light rail to the streets, tram link was implemented in London Borough. About 180,000 people are currently served by the system, and it sees

a significant volume of ridership, roughly 16 million passengers annually, with 20% of these trips initially originating from cars.

London, Freiburg, and Lagos only have highways, roads, bus networks, and rail lines in common in terms of their transport infrastructure. However, Lagos, which has the highest population among the three cities, has the least extensive rail network (see Figure 5) and poor bus service.

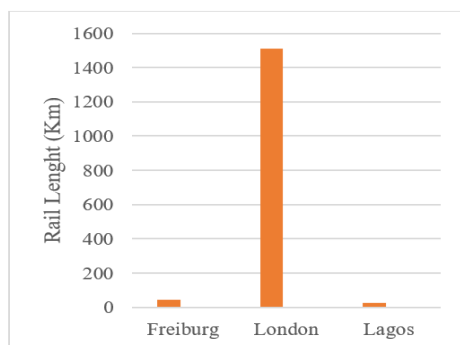


Figure 5. Train Line Length (Km) for The Three Cities

The bus service in Lagos is not on time and has few priority lanes, thereby making it less efficient and reliable. There are more than 9000 public buses in Lagos, including government and private buses. The Lagos Metropolitan Area Transport Authority (LAMATA), which is responsible for operating the government-owned vehicles, operated only 102 BRT buses on 12 routes in Lagos. The dominance of minibuses (danfos) with poor driving experience in Lagos has contributed to the menace of traffic congestion in Lagos. London buses are operated by a variety of companies, including Transport for London, Go-Ahead Group, and First Group, serving over 700 routes, and carrying over two billion people annually. London has also explored other transport infrastructure to promote sustainability, which includes tram links, river service, and underground lines, while Freiburg prioritises park and ride facilities, cycling infrastructure, inter-modality, pedestrian zones, and traffic calming measures with a comprehensive public transportation system operated by the Freiburger Verkehrs AG (VAG).

6.3. Traffic Congestion

The inadequacy of infrastructure and rising demand contribute to traffic congestion, which severely hinders the effectiveness and operation of transportation networks. Traffic jams, longer commutes, increased fuel consumption, and negative environmental effects are some of the indicators. The problem of reducing traffic congestion intensifies as cities encounter population densities and a

centralization of economic activity. Among the three cities, Lagos faces severe traffic congestion due to its high population density arising from behavioural factors, inadequate infrastructure, violation of traffic laws and limited transport system. Because of the constant traffic jams, some locals have made a living out of trading in between the congestion.

The implication of traffic congestion in Lagos is that the cost of commuting by workers increases as transportation takes up a chunk of their salary, thereby impacting their effort rate, while time loss due to congestion also reduces the effectiveness of workers and productivity through lateness to places of work. Freiburg has been focusing on sustainable transport options through its traffic management plan and cyclist path updated every 10 years since experiencing population growth. It has benefited from sustainable urban planning while also prioritising pedestrians, cyclists, and public transport, making it a more liveable and environmentally friendly city when compared to Lagos and London.

Even though there are many high-value activities connected to jobs in London, most of them are concentrated in the "Central Activities Zone" (CAZ), which makes up 2% of the city's total area but accounts for almost 30% of all occupations. Traffic congestion has witnessed a significant reduction through congestion charges, real-time traffic monitoring, and an intelligent traffic signal system. The differences in population, infrastructure, urban planning, and traffic management approaches contribute to variations in traffic congestion levels among the three cities.

6.4. Transport Policy

Transport policies play a pivotal role in shaping the design, operation, and sustainability of transportation networks. They required striking a careful balance between reducing environmental impact, improving overall quality of life, and satisfying the population's desire for mobility. Addressing these complexities requires a multidisciplinary approach that considers environmental concerns, demographic trends, technological improvements, and socioeconomic factors. Freiburg and London's transport policies have been successful in reducing congestion, improving air quality, and promoting sustainable transportation, thereby serving as models for other cities to foster sustainability in their transport systems.

Freiburg's and London's transport policies are closely linked to the principles of compact and mixed-use neighbourhoods, which reduce the need for long distance travel and are based on the principles of sustainability, efficiency, accessibility, and safety. Their transport policies are implemented through continuous investment in public transport, walking and cycling promotion, and car-free city centre

creation. Since the 1980s, Freiburg has increased the number of bicycles used by implementing various pro-cycling measures. Since 1976, the yearly average funding allocated to bicycle facilities has been €836,000. The city boasts over 400 km of interconnected cycling paths, over 9,000 bike parking spots in Freiburg's downtown and bike-and-ride areas near bus and tram stops, and bikes accounted for over 20% of all travel in 2011. In London, the launch of the Car Club Coalition (CCC) in September 2014, which consists of the Greater London Authority (GLA), the London Councils, the TfL, and key stakeholders, serves as the foremost evidence for the existence of a supportive network for the car sharing sector. It is widely acknowledged by the Coalition that by promoting the use of cleaner cars and a greater variety of sustainable modes of transport on London roads, the car-sharing industry might help address several sustainability issues, including air pollution.

Lagos relies heavily on informal minibus services and lacks a comprehensive public transport network. Lagos is far behind in developing a policy that will highlight the need for comprehensive transport planning and investment while also promoting safety, efficiency, accessibility, and sustainability. Recognising the value of an integrated mass transit system across the city, Freiburg and London have been putting policies in place to enhance air quality and reach net zero in transportation, including low emission zones and incentives for the use of electric vehicles. They have established a "city of short distances" through planning and design, allowing for significant usage of bicycles, walking, and public transportation.

Air pollution from fossil fuels is viewed as a serious threat to sustainable growth in Lagos, as the projected economic impact stands at 60%, from £0.82 billion to £4.9 billion between 2019 and 2040 under a Business-As-Usual (BAU) scenario (see Figure 6).

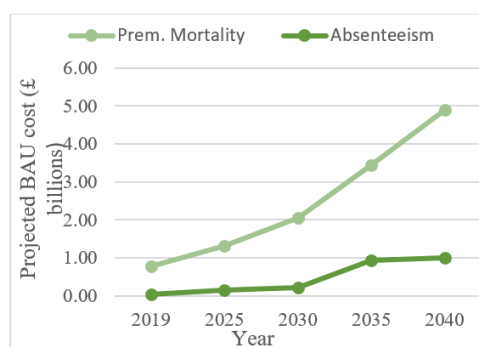


Figure 6. Quantifying the Economic Costs of Air Pollution from Fossil Fuels [18]

Lagos is in close proximity to the most polluted megacities globally due to its PM_{2.5} concentration, which is above the WHO standards for an annual mean PM_{2.5} concentration of 10 µg/m³. Lagos has the

greatest number of premature deaths (over 11,200) in West Africa arising from exposure to ambient PM_{2.5}, making ambient air pollution a critical issue. The most vulnerable age group is children under five, and they should receive extra consideration when creating programmes to lessen the negative effects of air pollution on health through sustainable transport system. The high population in Lagos is an asset that is yet to be explored for improving its GDP while also fostering sustainability. Also, improving air quality will reduce infant mortality and absenteeism from work through health-related challenges.

7. Proposed Sustainable Cities Mitigation Measures – Lagos Transport

The three cities have some similarities and differences in terms of population, infrastructure, and policies. However, should Lagos City's rapid urbanisation be held responsible for the city's ongoing transport problems? I vehemently disagree since Lagos has not yet applied the lessons from sustainable cities to her own environment, considering the population, infrastructure requirements, and socioeconomic issues. Therefore, Lagos can apply sustainability initiatives from Freiburg and London's experiences to her own transport planning and implementation through the following measures:

7.1. Emphasis on Active and Public Transport

Both Freiburg and London place a high priority on active transport options like biking and walking, as well as reliable and easily accessible public transport. Lagos has the shortest public transport rail system relative to other megacities of its size (1.3km per million people), and with the current investment into the blue rail mass transit system and the BRT, Lagos will not be lifted from the list of cities with the least public transport capacity until the government commissions additional rail lines and other alternative transport solutions, especially tram systems, which are easier to develop with the present lack of space for expansion. It is high time Lagos took advantage of being an island by promoting sustainable ferry technology that reduces CO₂ emissions. Lagos can take note of their investments in pedestrian infrastructure, designated bike lanes, the integration of walking and cycling into public transit networks, the incorporation of technological solutions, like mobile applications for itinerary planning and real-time transportation updates, as well as subsidies or discount schemes for particular demographics like students, the elderly, and low-income people, as well as the delivery of instructional and training materials on the advantages and responsible usage of public and active transportation. Encouragement of active and public transport in Lagos will help decrease traffic

congestion, enhance air quality, and provide locals with sustainable mobility options.

7.2. Integrated and Comprehensive Transport Planning

Freiburg and London emphasise the importance of integrated and comprehensive transportation planning, as they both recognise that transportation is not an isolated entity but an integral part of urban planning and development. Lagos should focus on their approach, whose key elements include multimodal transportation i.e., creating a well-connected network that enables smooth transfers between modes, integrating modes like buses, trams, bicycles, and walking routes, and creating transport hubs that make it simple to switch between various modes in order to lessen dependency on personal vehicles, transit-oriented development, sustainable infrastructure, connectivity, and accessibility. This could be further accomplished by implementing smart transportation solutions like integrated ticketing systems, digital platforms for trip planning, adoption of mixed-use zoning to lessen the need for long-distance commuting, planning for nearby residential, commercial, and recreational spaces, investigating the possibilities of electric and hybrid vehicles, and making investments in charging infrastructure to lessen the environmental impact of transportation. By considering the interconnectivity between these elements, Lagos can improve accessibility, optimise transport routes, and reduce reliance on private cars.

7.3. The Stakeholder Participation and Community Engagement

In the planning and decision-making processes for transport, both cities actively involve the public and stakeholders. Lagos can learn from their strategies of seeking public input, fostering collaboration, and involving local communities through conducting public awareness campaigns to educate the community about the benefits of sustainable transport and its potential impact on the environment, health, and overall well-being; identifying and engaging with key stakeholders in the transportation sector, such as government agencies, local communities, non-governmental organisations (NGOs), businesses, and advocacy groups; asking for feedback from residents, community leaders, and businesses on their priorities for sustainable transport; incorporating participatory planning into the urban development process; taking into account cultural aspects and local contexts in engagement strategies to ensure they resonate with the diverse population. By including locals and stakeholders in the decision-making process, infrastructure improvements and transit plans can better reflect the preferences and needs of the populace, resulting in higher acceptance and effective execution.

7.4. Sustainable Financial Mechanism

Both Freiburg and London have implemented innovative financing mechanisms to support sustainable transport initiatives. Lagos can learn from their approaches, such as Establishing partnerships between the public and private sectors to finance sustainable transportation projects; putting in place value capture mechanisms like tax increment financing (TIF), development charges, or land value capture to finance transportation infrastructure; enacting congestion pricing systems to impose fees on vehicles for accessing certain areas during peak hours; attracting conscious investors by designating bond proceeds for eco-friendly projects; offering tax breaks for individuals and businesses adopting sustainable transportation practices. Exploring sustainable financing models can help overcome funding constraints and ensure adequate resources for investing in sustainable transport infrastructure and services. The full public sector capital investment in transport in Lagos is becoming a failure with growing demands on public budgets, especially in the health and education sectors, and this necessitates exploring other financial options, including totally private capital, some public capital, and substantial private capital, to meet the financial requirement of providing sustainable transport.

7.5. Congestion Fee and Low Emissions Zones

Low-emission zones and congestion pricing programmes have been developed in Freiburg and London, respectively, to lessen air pollution and control traffic. Lagos might benefit from their knowledge when creating comparable programmes to encourage the use of low-emission vehicles and discourage the use of private vehicles in areas of congestion. This action could be achieved by making sure that technology is strong and dependable to enforce emissions standards and congestion fees effectively; conducting a thorough traffic assessment of Lagos to identify high-emission areas and areas with congestion; modifying the models of low-emission zones and fees for congestion to fit the specific characteristics of Lagos, taking into account socioeconomic factors and the city's infrastructure; educating the public about the advantages of these policies; coordinating policies with establishing strict enforcement mechanisms, such as fines for non-compliance and frequent vehicle emissions testing; offering information on how to comply, the benefits, and the overall positive impact on the environment and health; and developing variable pricing to encourage off-peak travel and discourage needless trips. All these can help create a more sustainable transportation system and improve air quality.

7.6. Promotion of Car Free Living

Living without a car has become simpler in Freiburg and London, respectively. This entails offering incentives to automobile owners in addition to more affordable dwellings near public transport. Lagos may follow suit by providing tax benefits for residents of car-free areas; launching broad public awareness efforts to inform residents of the advantages of living without a car, such as less traffic, better air quality, and benefits to one's own health; improving public transportation's dependability, affordability, and accessibility to make it a practical substitute for driving one's own vehicle; working with employers to support telecommuting, carpooling, or flexible work schedules in order to minimise the need for daily commutes; encouraging programmes that link walking and cycling to schools; encouraging parents and children to drive less to school each day; establishing frequent car-free days or events in particular communities to help locals understand and enjoy the advantages of life without a car; constructing park-and-ride areas outside of the urban area.

8. Benefit of Adopting Sustainable Transport Measures

Lagos would experience three-dimensional sustainability growth if measures adopted by developed cities were transferred through the development and implementation of policies that prioritise community participation. Environmental sustainability will be achieved through improvements in the climate system by eliminating greenhouse gas emissions, improving air quality by reducing its impact on public health, reducing noise pollution, reducing fatalities resulting from traffic jams, and promoting conservation of natural resources by reducing the demand for fossil fuels. If Lagos adopted several air pollution reduction initiatives, the city might raise more than £1.4 billion in 2040 alone from premature mortality and absenteeism from work when compared to the existing situation (see Figure 7). Revenue generation from the public transport system, traffic offenders, congestion charging, emission control, and parking will contribute to the states' GDP and serve as a means of economic revival. Implementation of policies will create opportunities for local businesses while also result in the creation of multiple streams of employment for the people of Lagos, thereby reducing the unemployment rate among the residents. Social sustainability would be achieved in Lagos transport through the integration of the elderly, disabled, young, and low-income earners into the system, thereby making life better and encouraging equity as everyone is given the same possibilities regardless of their social standing. Also, road safety can be increased, resulting in fewer

collisions and injuries through traffic calming and better pedestrian infrastructure. Walking, cycling, and public transport can enhance public health by decreasing sedentary lifestyles and promoting physical exercise.

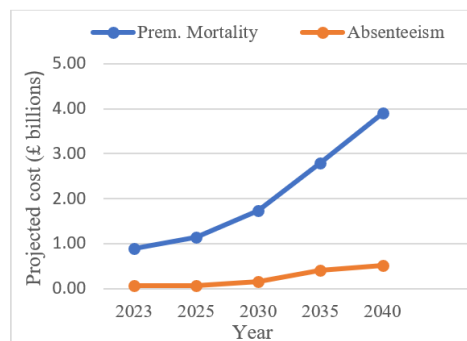


Figure 7. Projected Revenue from Implementing Air Pollution Reduction Measures [18]

9. Conclusion

To make Lagos sustainable and reduce the serious environmental, social, and economic issues brought on by traffic congestion and hazardous vehicle emissions, the public transportation infrastructure needed an update. Lagos is far behind in terms of transport infrastructure when compared to Freiburg and London, which have experienced sustainability in transport. The existing transport policy and the financial mechanism of full public sector capital need to be revisited to address the problems of providing an efficient and sustainable public transport system with a rising educational and health budget in Lagos. This would help in addressing the major problem associated with providing efficient and sustainable transport in Lagos while promoting the Lagos sustainability agenda.

The study recommends the review of the Lagos master plan while prioritising the framework and implementation strategy that give public participation significance to enhance adoption as a means of achieving sustainability in Lagos transportation. Furthermore, the plans should integrate transport and land-use planning, promote public-private partnership funding, implement stakeholder views in stages, and be flexible and adaptable over time to changing conditions. The study further recommends the formulation of policy towards maintenance and servicing of the existing transport infrastructure, enforcement of freight consolidation and delivery regulation, congestion charging enforcement, and car sharing promotion as the first phase of actions in achieving sustainability in Lagos.

Future studies should foster the collection of primary data when developing sustainability measures to ensure inclusiveness and adoption by the

public. It should further consider the implications of the air pollutants associated with transport on the life expectancy of Lagos residents. It should also consider adapting car sharing and freight policy enforcement to Lagos socioeconomic conditions in the development of a framework in the pursuit of Lagos as a sustainable city.

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