



THE GLOBAL ENGINEERING CONFERENCE ON SUSTAINABLE  
DEVELOPMENT AND WORLD FEDERATION OF ENGINEERING  
ORGANISATIONS EXECUTIVE COMMITTEE MEETINGS.

15<sup>th</sup> - 18<sup>th</sup> October 2024, Kigali, Rwanda

# Theme: Engineering Innovations for a Sustainable Future

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# **Sustainable Urban Mobility and Infrastructure in Sub-Saharan Africa: Engineering Pathways to Climate Mitigation and Inclusive Development**

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**All seasoned researchers and Industry practitioners with wealths of Expertise**



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### Introduction

- Over the last two decades, Sub-Saharan Africa has had rapid urbanisation beyond Global average (UN- Habitat 2020)
  - The reason has been tapping into attached opportunities to urbanisation;
- The rapid growth has placed immense pressure on urban infrastructure, particularly mobility systems, resulting in challenges such as traffic congestion, inadequate public transit, air pollution, and increased greenhouse gas emissions (World Bank, 2019);



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# Introduction Cont'd

- The challenges of the urban population increase need to be averted through sustainable urban mobility solutions that not only mitigate climate impacts but also foster inclusive development.

## AIM OF THIS STUDY

- To explore engineering pathways that can lead to sustainable urban mobility and infrastructure in Sub-Saharan Africa, with a focus on strategies that contribute to climate mitigation and inclusive growth.
- By examining both technological solutions and policy interventions, the study seeks to identify practical approaches that can transform urban mobility in ways that benefit all citizens, especially marginalised communities.
- Engineering innovations, such as the adoption of electric vehicles, green infrastructure, and integrated public transit systems, present opportunities for reducing carbon footprints and enhancing urban resilience (Africa Development Bank, 2021).
- Moreover, sustainable urban mobility plays a crucial role in improving access to essential services, reducing socio-economic disparities, and enhancing the overall quality of urban life (Gwilliam, 2017).

# Introduction Cont'd

## RATIONALE OF THE STUDY

- Lies in the recognition that sustainable urban mobility is not only a **key component of urban planning** but also a **critical element** in achieving broader development objectives,

- **Among them being:**

Climate action and Social equity (**Sustainable Development Solutions Network, 2022**).

- As cities become more densely populated, existing transport systems often characterised by informal services and inadequate infrastructure are proving unsustainable in almost all African nations.
- Without intervention, these conditions are likely to worsen, leading to increased emissions and a diminished quality of life for urban residents (Figueroa et al., 2018).
- **Hence, exploring engineering-based pathways to sustainable urban mobility is paramount to ensure cities in Sub-Saharan Africa develop in a manner that is both environmentally and socially sustainable.**

# CASE STUDY CITIES

- By highlighting case studies of cities that have adopted innovative urban mobility solutions, such as Kigali in Rwanda and Addis Ababa in Ethiopia;
- The study also aims to provide practical insights that can be replicated or adapted to other urban contexts across the region.
- These case studies demonstrate how an integrated approach that includes public transport improvements, non-motorised transport infrastructure, and community engagement can lead to more sustainable and inclusive urban environments (Cervero, 2013).
- Ultimately, the findings from this study will contribute to the discourse on urban sustainability by providing actionable recommendations for policymakers, engineers, and urban planners working towards climate-resilient and inclusive cities.

## METHODOLOGY

- Qualitative research approach to explore sustainable urban mobility and infrastructure in Sub-Saharan Africa, with a focus on engineering pathways that contribute to climate mitigation and inclusive development;
- Relies on secondary data sources, including academic literature, policy documents, and case studies, to understand the current state of urban mobility, identify challenges, and explore solutions that are being implemented across the region;
- study incorporates case study analysis to highlight practical examples of cities that have successfully implemented sustainable urban mobility initiatives;
- This methodological approach provided a grounded understanding of how different cities are addressing mobility challenges and showcases the role of engineering and policy interventions in fostering sustainable urban environments
- By combining both Lit rev & case studies this study aims to develop actionable recommendations that can inform future efforts in engineering sustainable urban mobility across Sub-Saharan Africa

## LITERATURE REVIEW

- Lit Review has confirmed that Urban mobility plays a pivotal role in the socio-economic development of cities, influencing both environmental outcomes and social equity;
- With UN-Habitat projection of 1 Bn population in urban area by 2050;urban mobility will be at risk with such inconveniences like congestion and pollution unless an action is taken;
- This necessitates a shift towards sustainable urban mobility that supports climate mitigation and inclusive development (Gwilliam, 2017)
- Such Engineering pathways as the adoption of electric vehicles, green infrastructure, and integrated public transport systems, offer promising solutions to challenges by contributing to reduced greenhouse gas emissions and improved access to services (Africa Development Bank, 2021).



# Noted Engineering Pathways in Climate change mitigation

## **1. Electrification of urban transport systems:**

- Public transit electrification: Buses and Minibuses are crucial means of reducing carbon emissions in cities across Sub-Saharan Africa (Sustainable Development Solutions Network, 2022)
- Studies indicate that electric buses not only reduce emissions but also offer economic advantages over the lifecycle of the vehicles compared to their diesel counterparts, due to lower operating costs and reduced energy consumption (Figuerola et al., 2018);

## **2. Development of infrastructure to support non-motorised transport (NMT), such as cycling and walking.**

- Lack of adequate NMT infrastructure, including pedestrian walkways and bicycle lanes, limits people's mobility options and disproportionately affects low-income residents (Cervero, 2013).
- Engineering solutions aimed at improving NMT infrastructure contribute to climate mitigation by reducing the dependence on motorised transport and promoting zero-emission alternatives (Gwilliam, 2017)
- Rwanda serves as a best practice UN Habitat 2020 in the promotion of non-motorised transport, with initiatives that include car-free zones and improved cycling paths

# POLLUTION CONTROL THRU NMT INFRA PROMOTION



## More Eng. pathway :Transit-Oriented Development (TOD)- -Ethiopia's Light Rail infra

Alligns urban planning with transport infrastructure to reduce congestion, promote the use of public transit (Litman, 2018),reduce pollution and providing a sustainable alternative to car travel



# MORE ENG. PATHWAY : RENEWABLE ENERGY TECHNOLOGIES INFRA TO ENHANCING CLIMATE RESILIENCE

r-powered streetlights and electric vehicle (EV) charging stations to reduce dependency

on-renewable energy sources and lower the overall carbon footprint of urban

structure (Benefits: reduced emissions, improved public safety, encourages non-motorised travel in late hours )

PHOTO OF CHARGING STATION & ELECTRIC CAR, SOLAR STREET LIGHT

# MORE ENG. PATHWAY : SMART MOBILITY SOLUTIONS THRU DIGITAL TECHNOLOGY

ation of Mobility as a Service (MaaS) platforms:

ides access to various transport modes through a single application to improve:

venience and attractiveness of public transport,

reduce reliance on private vehicles;

ence clean air quality for urban dwellers

# Urban Mobility Challenges in Sub-Saharan Africa

inadequate public transport systems, (unreliable due to insufficient investment in fleet maintenance and expansion (World Bank, 2019)

reliance on informal transportation networks,(lack of regulation means these services are often unsafe, environmentally inefficient, and contribute to congestion (Cervero, 2013).

poor infrastructure for non-motorised transport (NMT), affects low-income residents who cannot afford private vehicles hence increased accident occurrence in K'la (Sustainable Development Solutions Network, 2022)

vulnerability to climate impacts -**floods Accra Ghana**-(increased travel times and reduced economic activity (Figuerola et al., 2018)

# Sustainable Mobility Solutions in Sub-Saharan Africa

Electric Mobility

Non-Motorised Transport (NMT) Infrastructure

Improvement of Public Transport Systems (BRT)

Digital Mobility Solutions and Mobility as a Service (MaaS)-ride-hailing apps, and digital ticketing

Cashless system eg Nairobi, Kigali with increased cash safety

Integrated Land Use and Transit-Oriented Development (TOD)-aligns land use and transit infra

ease in urban mobility

Renewable Energy Integration in Transport Infrastructure-solar street lights, EV charging stations

# Engineering Sustainable Urban Infrastructure in Sub-Saharan Africa

Green Building Technologies-minimising the environmental footprint of urban areas ("Green Star" Certification encourages the development of buildings that incorporate energy-efficient lighting, natural ventilation, and water conservation measures)

Renewable Energy Integration

Smart Water Management Systems-ensure equitable access to clean water, minimise waste, and mitigate flood risks eg rainwater harvesting, advanced filtration, and leak detection technologies, play a critical role in enhancing water efficiency in urban areas (Gueroa et al., 2018).

Green Urban Spaces-help regulate urban temperatures, reduce pollution, and provide recreational areas for city residents (Cervero, 2009)

Sustainable Urban Transport Infrastructure-BRT promotes low-emission mobility options, reducing congestion, and improving access to essential services in TZ

Sustainable Waste Management Systems-recycling, composting, and waste-to-energy technologies eg Waste-to-Wealth program in Nigeria (Cervero, 2013) and waste recycling in Kigali to make clean city UN-Habitat 2020



# Case Studies

following case studies explore successful initiatives in cities

Dares Salaam, Tanzania: Bus Rapid Transit (BRT) System-over 200,000 commuters daily (World Bank, 2019)

Kigali, Rwanda: NMT Infra-pedestrian-friendly sidewalks, dedicated cycling lanes, and car-free zones (UN-Habitat, 2020)

Surabaya Ride-shared electric bicycles to encourage cycling as a primary mode of transport

Addis Ababa, Ethiopia: Light Rail Transit (LRT) System

Lagos, Nigeria: Waste-to-Wealth Program

Durban, South Africa: Renewable Energy Integration-"Solar PV Pilot Project" installing solar panels on municipal buildings,-Reduce greenhouse gas emissions and energy costs.

Kampala, Uganda: Flood-Resilient Infrastructure-stormwater retention ponds, improved drainage channels, permeable pavements-Reduce runoff and enhance groundwater infiltration (Litman, 2018).

# KIGALI ADOPTED GREEN INITIATIVES



# CONCLUSION

As cities in the region face rapid population growth, unplanned urbanisation, and climate-related challenges, there is an urgent need to adopt engineering solutions, innovative policies, and integrated urban planning approaches that prioritise sustainability and resilience.





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