SSATP
Africa Transport Policy Program

TRAFFIC MANAGEMENT FOR SUB-SAHARAN AFRICAN CITIES

THE WAY FORWARD

Fatima Arroyo-Arroyo
Gladys Frame

An international partnership supported by:

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ACRONYMS

AACRA	Addis Ababa City Roads Authority
AADF	Annual Average Daily Flow (in vehicles)
AARTB	Addis Ababa Road and Transport Bureau
API	Application Programming Interface
ANPR	Automatic Number Plate Recognition
ARA	Agency Responsibility Analysis
ATC	Area Traffic Control
AUT	Automatic Updating of TRANSYT
AVL	Automatic Vehicle Location
BRT	Bus Rapid Transit
CBD	Central Business District
CCTV	Close Circuit Television (cameras)
CDR	Call Data Record (from mobile phones)
CO2	Carbon Dioxide
DUR	Department of Urban Roads (of the Ministry of Roads and Highways)
EASI	Enable, Avoid, Shift, Improve
FBC	Fourah Bay College (Freetown, Sierra Leone)
FCT	Federal Capital Territory
FCTA	Federal Capital Territory Administration
FIFA	Fédération Internationale de Football Association.
FMoT	Federal Ministry of Transport
FMoW	Federal Ministry of Works
FRH	Functional Road Hierarchy
FRSC	Federal Road Safety Corps (Nigeria)
FT	Fixed Time (as applied to ATC systems)
GFA	Gross Floor Area
GHA	Ghana Highways Authority
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GRSF	Global Road Safety Facility
GUTS1	Guangzhou Urban Transport Study 1 (1993)
GUTS4	Guangzhou Urban Transport Study 4 (2009)
ICM	Integrated Corridor Management
ICR	Implementation Completion Report (World Bank)
ICT	Information and Communications Technology
IRUMP	Integrated and Resilient Urban Mobility Project (Freetown, Sierra Leone)
ITDP	Institute for Transportation Development and Policy
ITS	Intelligent Transport Systems
KCMP	Kigali Comprehensive Master Plan (update 2018)
KeNHA	Kenya National Highways Agency
KTMP	Kigali Transport Master Plan (2013)
KURA	Kenya Urban Roads Authority

LASMoT	Lagos State Ministry of Transport
LASMoWI	Lagos State Ministry of Works and Infrastructure
LAMATA	Lagos Metropolitan Area Transport Authority
LASTMA	Lagos State Traffic Management Authority
LED	Light Emitting Diode
LRT	Light Rail Transit
MAAS	Mobility as a Service
MiM	Midtown In Motion
MININFRA	Ministry of Infrastructure (Rwanda)
MMDAs	Metropolitan, Municipal and District Assemblies
MoT	Ministry of Transport
MOTIHUD	Ministry of Transport, Infrastructure, Housing, Urban Development & Public Works (Kenya)
MTTD	Motor Transport and Traffic Directorate
MV	Motor Vehicle
NMT	Non-Motorized Transport (pedestrians and cyclists)
NMV	Non-Motor Vehicle (includes bicycles and e-bicycles)
NOx	Nitrogen Oxides
PBD	Parking Benefit District
PCN	Penalty Charge Notice
PCU	Passenger Car Unit
PGS	Parking Guidance System
PM10	Particulate matter with inhalable particles with diameters of< micrometers.
PNR	Private Non-Residential (referring to workplace parking)
PT	Public Transport
PTAL	Public Transport Accessibility Levels (as deployed in London)
RTDA	Rwanda Transport Development Agency
RUE	Road User Education
RURA	Rwandan Utilities Regulation Agency
SCATS	Sydney Coordinated Adaptive Traffic System
SCOOT	Split Cycle Offset Optimization Technique
SSA	Sub-Saharan Africa
SSATP	Africa Transport Policy Program
SUTP	Sustainable Urban Transport Project
TA	Transport Authority
TCC	Traffic Command Center
TCT	Transport for Cape Town
TD	Transport Department
TDA	Transport and Urban Development Authority (Cape Town)
TDM	Transport Demand Management
TfL	Transport for London
Three Es	Engineering, Enforcement and Education
TIA	Traffic Impact Analysis
TM	Traffic Management
TMA	Traffic Management Agency (Addis Ababa, Ethiopia)
TMC	Traffic Management Center (Cape Town, South Africa)
TOPIS	Transport Operation and Information Service (Seoul, South Korea)
TPMO	Transport Programs Management Office (Addis Ababa, Ethiopia)
TPI	Third Party Insurance
TRANSIP	Transport Systems Improvement Project (World Bank, Addis Ababa, Ethiopia)
VA	Vehicle-Actuated (as applied to ATC systems)

ES.

EXECUTIVE SUMMARY

In developing cities in Sub-Saharan Africa, concerned citizens across the social spectrum are calling for transportation authorities to transform their traffic systems to be safer, more efficient, reliable, and convenient to use. New and improved roadways, better pedestrian amenities and innovative parking systems can enable city dwellers to better perform their work, shop, live, and access crucial public services in a more harmonious environment. Providing a well-managed traffic system with improved traffic flows, safer pedestrian zones, and better access to affordable parking is an important aspect of improving daily life. Yet many critical gaps exist in current traffic management systems. This report will examine those deficiencies in detail, compare the kind of reforms that are being implemented successfully in other cities experiencing similar challenges, and provide a comprehensive set of specific policy recommendations and traffic management measures that would have both an immediate and long-term positive impact on the quality of life and enhancement of commerce in many Sub-Saharan African cities.

THE STATE OF TRAFFIC MANAGEMENT AND THE CASE FOR CHANGE

The current condition of road systems, Non-Motorized Transport (NMT), and parking management in many Sub-Saharan African cities has its basis in outdated institutions, a lack of resources, and a lack of expertise and knowledge. Traffic management often falls prey to certain systemic gaps created by the deficiencies of entrenched bureaucratic legacy institutions which have hindered innovation for many years. These are often manifested by the lack of on-street physical engineering measures, educational programs that promote road safety and road user guidelines, and proper enforcement of local traffic ordinances. Despite the ability of some developing cities around the world to transform the scale and scope of traffic management systems and services, the lack of institutional capacity in many Sub-Saharan cities often prevents the most basic set of reforms from being implemented. A better institutional framework for traffic management is necessary, and this report encapsulates the major themes that are key to long-lasting reform and successful outcomes.

FINDINGS AND RECOMMENDATIONS

This report explores how to establish important priorities in traffic management. It is neither a toolkit nor a quick fix; rather, it focuses on realistic options for traffic management policies and measures that can be used by local transport officials, international and national transport agencies, universities, and local entrepreneurs. Each theme explored in this report provides a roadmap and guidelines for traffic authorities to follow. The implementation of a Functional Road Hierarchy (FRH), for example, is an important factor for determining the predominant function of a road within mixed functions, and achieving safe, efficient road use.

This report also presents five separate and complementary themes that provide African policymakers with tools to develop a stronger institutional foundation for sustainable, safe, and affordable urban traffic management in Sub-Saharan African cities. Known as the "EASI" (Enable, Avoid, Shift, Improve) Framework, these themes emphasize a more people-centric approach to adopting non-motorized modes of transport and addressing parking challenges, while embracing Intelligent Transport Systems (ITS) and technology to improve safety and efficiency across the board. *See a comprehensive outline of the EASI principles below.*

The five themes are influenced by successful outcomes in European, South American, and Asian cities. These cities evolved in similar circumstances to Sub-Saharan African cities and crafted their own roadmaps to traffic management success. Moreover, these themes are entirely consistent with the United Nations Sustainable Development Goal 11: "Making cities and human settlements inclusive, safe, resilient and sustainable." The proposals also build on some measures that are currently evolving in a few Sub-Saharan African cities.

NEXT STEPS AND BENEFICIAL OUTCOMES

The report provides a roadmap for leveraging resources and integrating a variety of practical management approaches to ensure transformative outcomes for a more complete, reliable, and responsive traffic sector. These solutions include specific recommendations for improving operational safety and efficiency through the development of "bottom-up" approaches in Intelligent Transport Systems (ITS) that utilize big data and other technological innovations, Transport Demand Management (TDM), Integrated Corridor Management (ICT), Area Traffic Control (ATC), and other critical elements. These recommendations may take years to implement across Sub-Saharan African cities, but they reflect all aspects of a framework necessary to address the unprecedented pace of urbanization over the past 60 years.

The first step in evaluating the many options for improving traffic management in Sub-Saharan Africa is to understand how the five traffic management themes fit into the elements of the EASI framework below:

FIGURE ES.1:

The EASI Framework and Traffic Management

The EASI framework used by the Africa Transport Policy Program (SSATP) defined a set of specific policy actions according to four areas of intervention: ENABLE, AVOID, SHIFT, and IMPROVE. The five themes for traffic management within the EASI framework are the following:

ENABLE	**stronger institutional foundations for traffic management.**
AVOID	**inappropriate land use and inefficient road use by developing a Functional Road Hierarchy (FRH).**
SHIFT	**the focus from motorized modes through pedestrian and other Non-Motorized Transport (NMT) measures using a people-centric approach.**
SHIFT	**the focus from motorized modes through parking management.**
IMPROVE	**IMPROVE safety and efficiency through Intelligent Transport Systems (ITS).**

Most of the recommended actions within the five themes are medium-term interventions with one long-term institutional action. However, there are five short-term actions which can be adopted; three of these focus on developing Intelligent Transport Systems (ITS) and two are related to the development of an institutional framework for traffic management. These are presented in the table below.

1. "Africa Transportation Policy." SSATP. Accessed September 08, 2021. https://www.ssatp.org/

Table ES.1:
Short, Medium and Long-Term Actions within the Five Themes for Traffic Management

Level	Theme	Task
SHORT TERM		
Strategic	IMPROVE safety and efficiency through ITS	Learn from local and international experience relevant to SSA cities.
Tactical	IMPROVE safety and efficiency through ITS	Develop a regulatory and institutional framework for ITS.
Operational	IMPROVE safety and efficiency through ITS	Install "bottom-up" ITS focusing on traffic signals, ATC and crowd-sourced apps for mobility as a service.
Tactical	ENABLE institutions for traffic management	Enable knowledge transfer and capacity building.
Operational	ENABLE institutions for traffic management	Strengthen local institutions through innovative data collection.
MEDIUM TERM		
Strategic	ENABLE institutions for traffic management	Build on existing institutional structures with Cape Town, Addis Ababa, and Kigali as models.
Strategic	ENABLE institutions for traffic management	Coordinate with other agencies.
Strategic	ENABLE institutions for traffic management	Examine two scenarios for reforming the traffic police.
Strategic	AVOID inappropriate land use and achieve efficient roads through an FRH	Learn from local and international experience relevant to SSA cities.
Strategic	AVOID inappropriate land use and achieve efficient roads through an FRH	Initiate a program to reform road categorization based on functions.
Tactical	AVOID inappropriate land use and achieve efficient roads through an FRH	Establish an FRH within a regulatory framework.
Operational	AVOID inappropriate land use and achieve efficient roads through an FRH	Implement TM measures in a pilot area to reinforce the predominant function(s) of selected roads.
Strategic	SHIFT the focus away from motorized modes in a people-centric approach	Learn from local & international experience relevant to SSA cities.
Tactical	SHIFT the focus away from motorized modes in a people-centric approach	Develop and set out the strategic approach.
Operational	SHIFT the focus away from motorized modes in a people-centric approach	Implement "bottom-up" pedestrian schemes.
Strategic	SHIFT the focus away from motorized modes in a people-centric approach	Learn from local international experience relevant to SSA cities.
Strategic	SHIFT the focus away from motorized modes through a parking strategy	Develop a parking strategy for SSA cities.
Tactical	SHIFT the focus away from motorized modes through a parking strategy	Develop conceptual parking management plans for SSA cities.
Tactical	SHIFT the focus away from motorized modes through a parking strategy	Investigate the potential of Parking Guidance Systems.
Operational	SHIFT the focus away from motorized modes through a parking strategy	Develop a parking business plan.
LONG TERM		
Strategic	ENABLE institutions for traffic management	Develop new institutional structures and rationalize their functions.

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THEME 1

ENABLING stronger institutions for traffic management at the national, federal, state and city levels is key to implementing a comprehensive range of measures. This is a "top-down" activity and it has a long-term timeframe. This first theme explores options for improving institutions as follows:

- Developing new institutional structures and rationalizing their functions.
- Building on existing institutional structures with Cape Town, Addis Ababa, and Kigali as models.
- Developing institutions for Intelligent Transport Systems (ITS).
- Coordinating with other agencies.
- Examining two scenarios for reforming the traffic police.
- Enabling knowledge transfer and capacity building.
- Strengthening local institutions through innovative data collection.

The roadmap and timeframe for institutional development is summarized below.

Table ES.2:
Roadmap and Timeframe for Institutional Development

EASI Framework	Traffic Management Institutional Potential	LEVEL	TIMELINE
ENABLE	**Establish better institutions for Traffic Management to ENABLE a strong institutional foundation.**		
1. Developing new institutional structures and rationalizing their functions.	An institutional framework for traffic management would comprise the following: • A national/federal level responsible for policies, strategies, standards, specifications and design manuals, legislation, ITS strategy and policy. • A local level responsible for planning, design, implementation, maintenance, local monitoring and evaluation, regulations, and enforcement.	STRATEGIC	LONG TERM
2. Building on existing institutional structures with Cape Town, Addis Ababa and Kigali as models.	• Cape Town: International institutional model embeds traffic management in a comprehensive structure. • Addis Ababa: The city itself has responsibility for most traffic management functions from policy and planning, funding, regulation, infrastructure, equipment, operations, maintenance, and enforcement, with the traffic police having minimum responsibilities. • Kigali: Traffic management has started to flourish within the framework of broader transport plans; the city government itself has a centralized, yet locally specific role in traffic management.	STRATEGIC	MEDIUM TERM
3. Developing Institutions for Intelligent Transport Systems (ITS).	ITS present a different case for the institutional framework to be at national or ministry level. ITS are part of a rapidly expanding technological revolution that is not just concerned with transport but with ubiquitous connectivity throughout citizens' lives and livelihoods.	STRATEGIC	MEDIUM TERM
4. Coordinating with other agencies.	The key areas for coordination include: urban development strategic planning; transport planning; urban infrastructure; PT; road safety agencies; law enforcement agencies; ITS; police and traffic police; driver and vehicle licensing database.	STRATEGIC	MEDIUM TERM
5. Examining two scenarios for reforming the traffic police.	The first scenario envisages a minor role for the traffic police in enforcement only; the second scenario envisages a broader role with the traffic police becoming involved in traffic engineering and design, and ITS.	STRATEGIC	MEDIUM TERM
6. Enabling knowledge transfer and capacity building.	• Traffic management courses at universities and colleges. • Counterpart and on-the-job training. • Placements and embedding of local staff with international institutions	TACTICAL	SHORT TERM
7. Strengthening local institutions through innovative data collection.	The experience of Freetown, Sierra Leone data collection through anonymized mobile phone data can lead to focused traffic management solutions and lead to institutional development.	OPERATIONAL	SHORT TERM

THEME 2

AVOIDING inappropriate land use by developing a Functional Road Hierarchy (FRH) establishes a foundation for successful traffic management. An FRH is useful for establishing priorities for other road infrastructure such as new construction, Public Transport (PT), and road safety. However, an FRH is particularly relevant to traffic management, where rapidly deployed small-scale measures can help enable the proper functions of each road in a city to the desired effect. The second theme focuses on adopting an FRH approach for developing the road network, which establishes the predominant function of each road and helps reduce incompatible mixed functions. In this respect, the city of Ouagadougou, Burkina Faso has provided a good roadmap by using the FRH concept to prioritize its road surfacing program and advance the implementation of paving over dirt roads. This report also provides a roadmap on how to categorize roads in an FRH, and then moves onto developing measures to reinforce the desired hierarchy, thus making roads more people-centric and PT-friendly. Moreover, the report caters to the needs of all road users including pedestrians and cyclists, not just motor vehicles.

The roadmap and timeframe for achieving an FRH is shown below.

Table ES.3:
Roadmap and Timeframe for an FRH

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
AVOID	**Establish an FRH to AVOID inappropriate land use and achieve efficient road use.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• The road categorization systems in many cities in developed countries are based on road functions rather than physical characteristics or design standards; thus, it is useful to study models from the UK, the Netherlands, Europe, North Africa, and other countries. • Build on Ouagadougou's road hierarchy (for road pavement upgrading from dirt roads to paved roads) and explore the potential for expanding the functional definition to apply to road users and land use. • Identify which models of good international practice have the potential to be adopted for Sub-Saharan African cities; this could be different models for different cities.	STRATEGIC	MEDIUM TERM
2. Initiate a program to reform road categorization based on functions.	• Using existing road categorizations as a starting point, examine the functions of key individual roads to determine how well road functions are taken account of. • Draw up a program to refine road categories and base them on road functions for the cities studied, together with the potential to replicate the model nation-wide.	STRATEGIC	MEDIUM TERM
3. Establish an FRH within a regulatory framework.	• Redefine the road classification within a regulatory framework.	TACTICAL	MEDIUM TERM
4. Implement TM measures in a pilot area to reinforce the predominant function(s) of selected roads.	• Carry out a pilot classification/ categorization in a trial area. • Implement road surface upgrade measures and TM interventions to reinforce the desired predominant function of the selected roads; ideally each road should be designed to have a main or predominant function; the road's cross-section, speed limit, and adjacent land use should enable a "natural" enforcement of the desired function by good design. • Evaluate the results. • Replicate throughout the city where appropriate.	OPERATIONAL	SHORT TERM

THEME 3

SHIFTING the focus of Sub-Saharan African cities towards pedestrians and other forms of NMT using a people-centric approach. Pedestrians and other forms of NMT are not well served in Sub-Saharan African cities despite a high percentage of trips being on foot. Streetscapes favor motor vehicles to the detriment of pedestrians' safety and convenience. To enable a modal shift, the third theme acknowledges that small measures lend themselves naturally to people-centric facilities such as the channelization of junctions, the implementation of little pockets in streetscapes for pedestrians, and the installation of zebra crossings and road tables. Such measures include the so-called "Three Es" (Engineering, Education and Enforcement), junction channelization, road tables, traffic calming, colored and textured road surfacing, and safety bollards to prevent vehicles from occupying walkways.

The roadmap and timeframe for developing pedestrian and other NMT measures is shown below.

Table ES.4:
Roadmap and Timeframe for Pedestrian and Other NMT Measures

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
SHIFT	**Develop pedestrian and other Non-Motorized Transport (NMT) measures to SHIFT the focus away from motorized modes in a people-centric approach using "Three E" measures, junction channelization, pedestrian pockets and traffic calming.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• Define "walkability" for Sub-Saharan African cities. • Build on good local experience from Kigali, Mombasa, Addis Ababa, and Tshwane. • Gather data and information; analyze situation, identify issues and barriers to walking. • Identify different types of walking, different walk trips for different purposes disaggregated by gender. • Case Studies: São Paulo, London, Barcelona, Guangzhou, Seoul, Singapore.	STRATEGIC	MEDIUM TERM
2. Develop and set out the strategic approach.	• Quantifying the pedestrian challenge. • Functional Road Hierarchy for NMT. • Pedestrian level of service. • Human scale of cities. • "Three Es": Engineering, Enforcement, Education. • Traffic calming.	TACTICAL	MEDIUM TERM
3. Implement "bottom-up" pedestrian schemes.	• Implement measures within the context of local pedestrian schemes. • Monitor and evaluate measures. • Replicate good practice citywide, nationwide and throughout the region.	OPERATIONAL	MEDIUM TERM

THEME 4

SHIFTING the focus of Sub-Saharan African cities away from motorized modes is key to enabling livable and greener cities. To enable such a modal shift, the fourth theme focuses on establishing a parking management system to kickstart a parking turnover makeover. This is where both on-street and off-street spaces are managed more efficiently to limit all-day commuter parking and allow a turnover of vehicles to serve local communities and generate revenue. This report notes that the window of opportunity for Sub-Saharan African cities to deploy parking management as a Transport Demand Management (TDM) measure and develop parking zones with differentiated pricing is rapidly closing. This issue needs to be addressed before streetscapes become overwhelmed with uncontrolled parked vehicles.

The roadmap and timeframe for achieving a parking management system is shown below.

Table ES.5:
Roadmap and Timeframe for Parking Management System

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
SHIFT	**Develop a parking management system and utilize parking as a Transport Demand Management (TDM) measure to SHIFT the focus away from motorized modes.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• International cities had good institutional foundations for managing parking because of the following factors: (1) reasonable land use policies; (2) development control; (3) Functional Road Hierarchies (FRH); (4) Traffic Impact Analysis (TIA) methodologies; (5) trip rates; (6) centralized vehicle and driver databases. • Local experience of Maputo and Addis Ababa as a "bottom-up" initial small step approach. • Forecasting parking demand. • Developing parking standards. • Smart parking, cashless parking, crowdsourced parking. • Mechanical parking systems, Parking Guidance Systems (PGS). • Parking as a business. • Parking benefits system.	STRATEGIC	MEDIUM TERM
2. Develop a parking strategy for Sub-Saharan African cities.	• Establish a zonal parking system with a differentiated and hierarchical charging system. • Develop parking standards including a PTAL approach. • Systematic pricing/charging policy.	STRATEGIC	MEDIUM TERM
3. Develop conceptual parking management plans for Sub-Saharan African cities.	• Establish a zonal parking system with a differentiated and hierarchical charging system. • Develop parking standards including a PTAL approach. • Systematic pricing/charging policy.	TACTICAL	MEDIUM TERM
4. Investigate the potential of Parking Guidance Systems.	• Intelligent Transport Systems (ITS) for parking and Parking Guidance Systems (PGS) and smart parking systems.	TACTICAL	MEDIUM TERM
5. Develop a parking business plan.	• Develop parking as a business and a service. • Privatization of management. • Public/private partnerships. • Civilianization of enforcement.	OPERATIONAL	MEDIUM TERM

Photo by Claude Nai on unsplash.com

THEME 5

IMPROVING safety and efficiency through Intelligent Transport Systems (ITS) may seem to be a remote achievement for Sub-Saharan African cities, many of which have few sets of traffic signals that work mainly in isolated modes with simple phasing. Yet these cities can benefit from the "latecomer advantage" (see Chapter 7) to leapfrog to the latest technologies in ITS such as crowd-sourced smartphone transport applications, traffic signals and on-street Area Traffic Control (ATC). The fifth theme emphasizes that ITS are achievable and affordable for developing cities, and can quickly transform them, enabling safer and more efficient traffic flows with better provision for NMT. Advances in technology mean that cities can not only take advantage of the latest technologies for on-street equipment, such as multi-phase traffic signal controllers and above-ground vehicle detection, but can also deploy the technologies in a step-by-step way. Even within a ten-year timeframe,[2] for example, ATC at the heart of ITS can be deployed step-by-step without utilizing all its functions initially. First, traffic signals can be deployed in isolated modes with simple phasing-in, then with more complex phasing-in and sub-area coordination after that, to be followed by full area coordination and fully adaptive ATC (see Chapter 7).

The roadmap and timeline for developing and deploying ITS is given below.

2. Typically, the lifecycle of ITS equipment in fast emerging Asian economies.

Table ES.6:

Roadmap and Timeframe for Developing and Deploying Intelligent Transport Systems

EASI Framework	Intelligent Transport Systems	LEVEL	TIMELINE
IMPROVE	**Utilize a smart city approach by deploying Intelligent Transport Systems (ITS) including crowd-sourced smartphone applications and making use of the latecomer advantage to leapfrog to the latest technology to IMPROVE traffic management and give it high status.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• Trends in smart cities. • Trends in smart mobility with the Chinese case is particularly relevant; Chinese cities have been rapidly transformed over the past 20 years through ITS: Chinese technology is making inroads into Sub-Saharan Africa.	STRATEGIC	SHORT TERM
2. Develop a regulatory and institutional framework for ITS.	• Capitalize on "latecomer advantages." • Deploy the benefits of user-centric, data-driven and "bottom-up" innovations; utilize the benefits of Big Data, especially crowd-sourced from individual smartphones. • Promulgate laws and regulations governing the use of personal data to ensure data privacy while enabling appropriate utilization of anonymized data.	TACTICAL	SHORT TERM
3. Install "bottom-up" ITS focusing on traffic signals, ATC, and crowd-sourced apps for Mobility as a Service.	**For traffic signals and ATC:** • Start off with sets of isolated traffic signals at selected junctions with simple phasing such as two-phase north/south and east/west movements. • Complement these traffic signals with the "Three Es": physical junction channelization engineering, education for road users, and enforcement of the traffic signal phasing. • Expand the isolated traffic signals to more junctions. • Experiment with more complex phasing whereby "green man" pedestrian phases can be signaled and where conflicting turns can be separately signaled in "late start" or "early cut-off" techniques. • Start to coordinate isolated signals where they are less than 500m apart. For longer distances, there can be little benefit in coordination due to platoon dispersion. Coordination can be done on a fixed time basis through timeclocks, for example. • Ensure that the traffic police are trained in the traffic signal capability so that they do not conflict with the phasing or switch off the signals. • Expand coordination into a small fixed time ATC system using the existing technologies in the traffic signal controllers. • Invest in further technology such as a fiber-optic communication network. This can be above ground if necessary. • Develop a Traffic Command Center (TCC) and expand the functions of ATC to include traffic monitoring cameras and electronic police enforcement cameras. • Consider utilizing detection methods, such as above ground detection, to coordinate the signals in a traffic adaptive mode. • Take care to minimize issues related to legacy ITS systems and be wary of assertive ITS vendors with proprietary systems. **For Mobility as a Service:** Further develop crowd-sourced transport and navigation apps to promote PT and paratransit systems.	OPERATIONAL	SHORT TERM

1.

INTRODUCTION AND CONTEXT

Traffic management is crucial to enabling sustainable urban mobility and shifting to a people-centric focus, especially in developing cities. Traffic management techniques are an essential component of new road construction, parking management, and Public Transport (PT) infrastructure such as bus rapid transit and light rail transit; their strongest benefit comes from making the best use of existing road networks to mitigate or defer the need for expensive infrastructure. Such techniques are a key element in managing congestion, providing for vulnerable road users, enabling safer roads, managing parking, and achieving a greener urban environment.

THE TRAFFIC MANAGEMENT MYTH IN SUB-SAHARAN AFRICAN CITIES

All too often, simple traffic management measures have not been widely implemented in Sub-Saharan African cities. Transport practitioners often cite the case that traffic management techniques can be comprised of straightforward solutions. Traffic management measures such as traffic signals, junction channelization, physical segregation of transport modes, and signs and road markings can often be seen as obvious and easy measures. In many Sub-Saharan African cities, however, good practices in traffic management have yet to be implemented and sustained. For example, in Addis Ababa, Ethiopia, the light rail transit system has not been supported by traffic management measures to ensure safe access to stations, safe vehicle movements under viaducts, and safe pedestrian track crossings.[3,4] In Ouagadougou, Burkina Faso, traffic signals have been installed with no stop-lines or junction channelization.[5]

The reasons for poor traffic management in Sub-Saharan African cities have their basis in bureaucratic institutions, a lack of resources, and a lack of expertise and knowledge. Entrenched, reticulated, and siloed institutions have hindered innovation and implementation and present a challenge for local practitioners. There is a dearth of funds for small scale measures. Funding from international agencies tends to be targeted to large projects resulting in a myriad of transport studies, and an array of work which merely puts forward recommendations for institutional frameworks, funding mechanisms, and toolkits for hypothetical management techniques. Some traffic management solutions have been included in these projects and studies but have tended to be afterthoughts or add-ons that have rarely been implemented. These projects and studies include those funded by the World Bank in Maputo,[6] Ouagadougou,[7] and Addis Ababa;[8] the African Development Bank in Abidjan[9] and Accra;[10] the Japanese International Cooperation Agency (JICA) in Abidjan[11] and Maputo;[12] the Institute for Transportation and Development Policy (ITDP) in Kenya, Senegal, Tanzania, and Mozambique;[13] and the Sustainable Urban Transport Project (SUTP) in Liberia and Namibia.[14] All these projects and studies have produced a raft of recommendations for traffic management to build on existing practices and expand current capacity.

3. SSATP Africa Transport Policy Program/Transitec, Final Report: Sustainable Mobility and Accessibility Policy in Cities of Ethiopia, October 2018.
4. https://thecityfix.com/blog/addis-ababas-new-light-rail-network-gets-a-safety-audit-celal-tolga-imamoglu-iman-abubaker/ accessed 16 February 2021.
5. https://www.tema.ru/eng/travel/burkina-faso/ accessed 13 February 2021
6. MAPUTO: The World Bank, Promaputo Projects I and II, https://projects.worldbank.org/en/projects-operations/project-detail/P096332?lang=en accessed 10 February 2021.
7. OUAGADOUGOU: The World Bank, Ouagadougou Urban Transport Project (P168963), Project Information Document/ Integrated Safeguards Data Sheet (PID/ISDS) Concept Stage | Date Prepared/Updated: 15-Jan-2020 | Report No: PIDISDSC25573.
8. ADDIS ABABA: The World Bank, International Development Association, Project Appraisal Document on a Proposed Credit in the Amount of SDR213 Million (US$300 Million Equivalent) to the Federal Democratic Republic of Ethiopia for a Transport Systems Improvement Project (TRANSIP), May 2016.
9. ABIJAN https://www.afdb.org/en/news-and-events/african-development-bank-group-approves-loan-to-improve-urban-transport-in-abidjan-16585 accessed 19 February 2021.
10. ACCRA: https://www.afdb.org/en/documents/ghana-accra-urban-transport-project-autp-ipr-june-2020 accessed 19 February 2021.
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13. https://www.itdp.org/ accessed 23 February 2021.
14. SUTP Sustainable Urban Transport Project https://www.sutp.org/ accessed 18 February 2021

Nevertheless, traffic management measures in Sub-Saharan African cities have not been implemented well if at all. The cities await a transformation on the ground. This report does not aim to replicate previous reports but rather to add value by focusing on realistic interventions that have a reasonable chance of receiving funding (either from local or international sources), enabling engagement from city governments, being successfully implemented, and being scaled up and replicated in other areas.

Traffic management toolkits are widely available for practitioners to utilize. Such toolkits are widely documented online and include those from the World Bank[15,16,17,18] the ITDP,[19,20,21] the SUTP,[22] and leading city agencies such as Transport for London.[23,24] This report serves as a guide for traffic management techniques that practitioners can start deploying to achieve on-street transformation.

A comprehensive approach to creating better traffic management systems is within the remit of the Africa Transport Policy Program's Urban Transport and Mobility Pillar and its use of the so-called "EASI" framework. This is consistent with SSATP's[25] key mission of providing African policymakers with the tools to develop sustainable, safe, and affordable urban transport in Sub-Saharan African cities. SSATP's activities also support the implementation of the United Nations Sustainable Development Goal 11: "Making cities and human settlements inclusive, safe, resilient and sustainable."[26] The conceptual framework termed "EASI" defines a set of specific policy actions within four areas of intervention.[27,28]

ENABLE. Establish an efficient and responsible system of governance capable of anticipating needs, guiding public action, and ensuring the integrated management and development of urban transport systems.

AVOID. Minimize the need for individualized motorized journeys through appropriate land use, planning and management.

SHIFT. Maintain or increase the modal shares of Public Transport (PT) and Non-Motorized Transport (NMT) such as walking and cycling.

IMPROVE. Improve the efficiency and safety of transport modes while minimizing their environmental footprint.

Within the EASI framework, five themes are presented to stimulate better traffic management practices. These themes are comprised of two "top-down" and three "bottom-up" approaches. The activities under each theme can be caried out separately but would benefit from integration.

The "top-down" approach includes the following principles:

- ENABLE stronger institutional foundations for traffic management.
- AVOID inappropriate land use and inefficient road use by developing a Functional Road Hierarchy (FRH).

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15. The World Bank, Improving Accessibility to Transport for People with Limited Mobility (PLM), A Practical Guidance Note, May 2013.

16. The World Bank ITS Toolkit, (which includes traffic management measures) *https://www.ssatp.org/sites/ssatp/files/publications/Toolkits/ITS%20Toolkit%20content/index.html* accessed 17 February 2021.

17. The World Bank, Cities on The Move, A World Bank Urban Transport Strategy Review, 2002.

18. Department for International Development, UK, World Bank Urban Transport Strategy Review Background Paper, Experience in Urban Traffic Management and Demand Management in Developing Countries, Final Report, John A Cracknell Traffic and Transport Consultant, October 2000.

19. ITDP/UN Habitat, Streets for walking & cycling, Designing for safety, accessibility, and comfort in African cities, July 2018.

20. *https://africa.itdp.org/publication/street-design-manual-for-urban-areas-in-kenya/* accessed 17 February 2021.

21. *https://africa.itdp.org/publication/bus-rapid-transit-for-dar-es-salaam-city-centre-street-typology/* accessed 17 February 2021

22. SUTP Sustainable Urban Transport Project *https://www.sutp.org/* accessed 18 February 2021

23. Streets Toolkit, Transport for London, (TfL) *https://tfl.gov.uk/corporate/publications-and-reports/streets- toolkit#on-this-page-0* accessed 17 February 2021.

24. Streetscape Guidance, Transport for London (TfL) Third Edition, 2017.

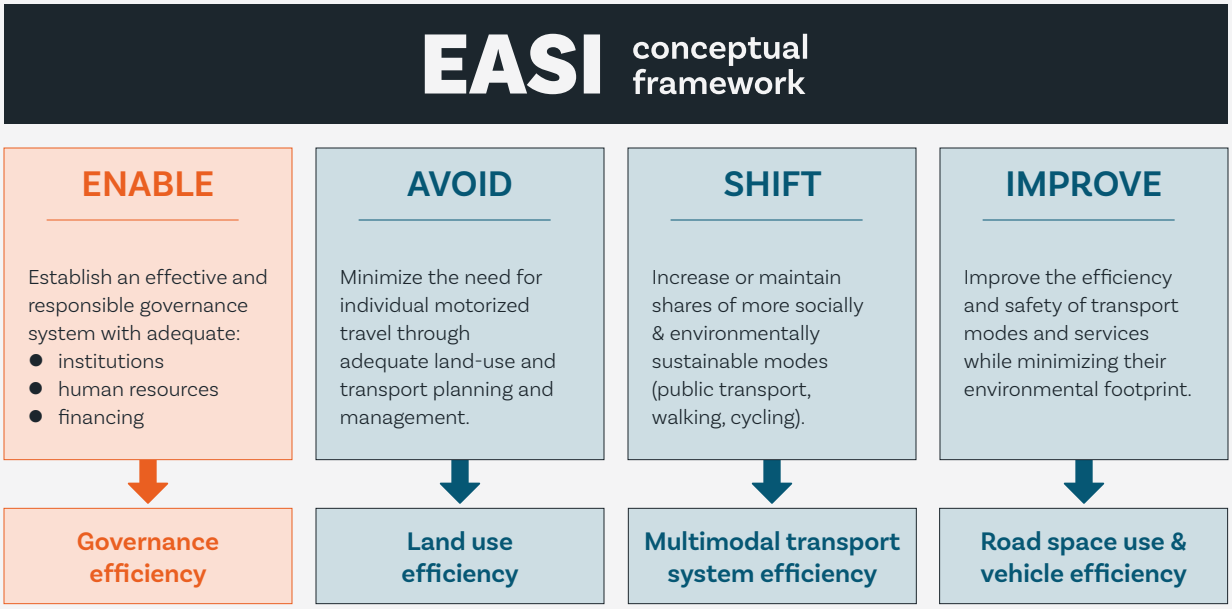
25. Africa Transport Policy Program, *https://www.ssatp.org/* accessed 23 February 2021.

26. *https://www.un.org/sustainabledevelopment/cities/* accessed 8 December 2020.

27. *https://www.ssatp.org/news-events/policies-sustainable-urban-mobility-accessibility-african-cities- policystrategy-papers* accessed 19 January 2021.

28. SSATP Africa Transport Policy Program/Transitec, Final Reports: Sustainable Mobility and Accessibility Policy for Kenya's Cities, Urban Areas of Ghana, Urban Areas of Nigeria, Cities of Ethiopia, and Cities of Rwanda, 2018.

FIGURE 1.1:
The EASI Conceptual Framework[29]



The "bottom-up" approach includes the following principles:

- SHIFT the focus from motorized modes to pedestrians and other Non-Motorized Transport (NMT) measures through a people-centric approach.
- SHIFT the focus away from motorized modes through parking management.
- IMPROVE safety and efficiency through Intelligent Transport Systems (ITS).

INTERNATIONAL AND DOMESTIC GOOD PRACTICE

The five themes are derived from successful outcomes in European, South American, and Asian cities; these cities expanded under similar circumstances to Sub- Saharan African cities in the past and crafted their own roadmaps to traffic management success. The proposals also build on some existing and evolving measures in a few

29. Ibid.

selected Sub-Saharan African cities and are within the context of the ongoing Africa Transport Policy Program (SSATP).

In particular, a "bottom-up" approach is needed to kickstart the implementation of traffic management. This report aims to provide roadmaps and guidance enabling transport professionals in city governments to quick start the implementation of small-scale traffic management measures. These traffic management techniques are suited to a "bottom-up" approach whereby short and medium-term measures can be quickly implemented without the longer timeframe needed for broader initiatives. Successful implementation (and subsequent operation and maintenance) of this approach is crucial to ensure that the techniques are not made disreputable due to poor practices, thus diminishing the status of traffic management.

ROAD SAFETY AND THE SAFE SYSTEM APPROACH

Traffic management and road safety are inextricably interlinked and comprise an important element of road safety interventions. The latest good practice approach to road safety is the safe system approach[30,31] which requires a shift in responsibility from those using roads to those designing them. This approach is based on the principle that errors are inevitable, but traffic fatalities and serious injuries should not be. The road system should be designed so that human error does not result in a serious or fatal outcome. Traffic management techniques should be designed and implemented using this safe system approach under the five themes' guiding principles.

TRAFFIC MANAGEMENT AND PUBLIC TRANSPORT (PT)

Traffic management is an essential component of PT infrastructure and operations. To enable safe and convenient access for passengers at bus rapid transit and light rail transit stops and stations, good traffic management is crucial in determining the location and design of these stops and stations which can feature physical channelization, signing, road markings, and traffic facilities such as bollards and barriers. To ensure smooth operation of bus services, bus lanes also require good traffic management design and enforcement (increasingly using enforcement cameras) together with traffic signal phasing to give buses priority at intersections.

Photo by Peace Itimi on unsplash.com

30. World Resources Institute (WRI), GRSF (Global Road Safety Fund), Embarq, World Bank, "Sustainable and Safe: A Vision and Guidance for Zero Road Deaths," 2018.

31. https://blogs.worldbank.org/transport/world-bank-launches-road-safety-performance-and-appraisal-tool accessed 6 April 2021.

Photo by Rachel Martin on unsplash.com

DISSEMINATION OF THE REPORT

This report aims to present realistic options for traffic management policies that local officials can build on, and roadmaps for them to follow. Moreover, this report could benefit a wider audience including:

- International and national partners of the World Bank including the African Development Bank (AfDB) and institutions such as the ITDP, the SUTP, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).
- International firms working in Sub-Saharan African cities.
- Universities and colleges in Sub-Saharan Africa such as the Center for Transport Development in Pretoria, the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (with its MSc program in Sustainable Transport, Transport Engineering and Transport Planning), the University of Nairobi in Kenya, the Universities of Kwazulu-Natal, Witwatersrand, Pretoria, Stellenbosch, and Cape Town in South Africa, and the Fourah Bay College in Freetown, Sierra Leone. This report could form the basis of a traffic management course.
- Local government officials and technical staff in Sub-Saharan African cities.
- High level officials, ministers and city mayors; there is a need to recruit local champions for traffic management.
- The local private sector and entrepreneurs in Sub-Saharan Africa; the sector is young, dynamic, and innovative.

Finally, Table 1.1 presents an overview of how the five themes (highlighted in bold) fit into the broader concept of traffic management within the EASI framework.

Table 1.1:
Traffic Management Potential in SSATP within EASI Framework

EASI Framework	Traffic Management Potential – The Five Themes
ENABLE	**1. Establish better institutions and practices for traffic management to ENABLE stronger and clearer institutional foundations.** ● Learn from international experience to ENABLE good practice. ● Develop better forecasting of traffic demands to ENABLE appropriate solutions and instigate Traffic Impact Analyses (TIAs). ● Improve road safety data collection and analysis to ENABLE more targeted measures to be designed and implemented.
AVOID	**2. Establish a Functional Road Hierarchy (FRH) to AVOID inappropriate land use and achieve efficient road use.**
SHIFT	**3. Develop pedestrian and other Non-Motorized Transport (NMT) measures to SHIFT the focus away from motorized modes to a people-centric approach.** **4. Develop Parking as a Transport Demand Management (TDM) measure to SHIFT the focus away from motorized modes by enabling a balance between demand and supply.**
IMPROVE	**5. Utilize a "smart city" approach by deploying Intelligent Transport Systems (ITS) including crowd-sourced smartphone applications and making use of the "latecomer advantage" to leapfrog to the latest technology to IMPROVE traffic management and elevate its status.** ● Deploy the "Three Es" of traffic management measures (Engineering, Education and Enforcement) to IMPROVE on-street traffic management.

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Burkina Faso. Map. May 12–14, 2012. https://www.tema.ru/eng/travel/burkina-faso/

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2.

TRAFFIC MANAGEMENT

KEY ISSUES FOR SUB-SAHARAN AFRICAN CITIES

Despite the difference in countries and cities, there are several emerging common themes and issues across the traffic management sector in Sub-Saharan Africa. These themes and their root causes have been well-documented and analyzed[32,33] and are summarized here.

EMERGING TRAFFIC MANAGEMENT ISSUES IN AFRICAN CITIES

Poor institutional framework for traffic management. There is a need for better institutional frameworks for traffic management measures to be successful. Traffic management often falls prey to certain systemic gaps created by the deficiencies of the existing institutions. There are many root causes for poor institutions, often legacies of changing governments and political systems. Typically, there are different agencies vying for control of the various elements of traffic management (see Table 3.1). For many Sub-Saharan African cities, the responsibility for traffic management (encompassing policy, planning, funding, development and implementation of measures) is often split between different government agencies and often at a higher level than the city or municipality where this task would ideally be suited. Traffic management operations are usually crisis-managed by traffic police on-street and on a piecemeal basis. Furthermore, analysis has shown that there is a significant level of civil society engagement in transport; civil society can be a powerful influence on what measures are implemented on-street.[34]

Road networks are not often structured in an FRH. An urban FRH is a way of defining roads by their functions not by their physical characteristics or design standards. Most roads perform many functions that are not often clear cut. Roads are not just for moving vehicles; for all road users, a balance needs to be achieved between traffic capacity, environment, speed, safety, convenience, and comfort. An FRH approach can ensure that the road network is people-centric, providing for pedestrians as well as vehicles. The development of roads in urban areas often follows an outdated administrative structure that is usually fragmented between the local and central levels. This fragmented structure often leaves urban communities without a clear definition of road function. The reasons for

32. SSATP Africa Transport Policy Program/Transitec, *Policies for Sustainable Urban Mobility & Accessibility in African Cities*: Policy/Strategy Papers and Diagnostic Studies for 12 Pilot Countries (Benin, Burkina Faso, Cote d'Ivoire, Ethiopia, Ghana, Guinea, Kenya, Mali, Nigeria, Rwanda, Senegal, Togo).

33. SSATP Africa Transport Policy Program/Transitec, *Final Reports: Sustainable Mobility and Accessibility Policy for Kenya's Cities, Urban Areas of Ghana, Urban Areas of Nigeria, Cities of Ethiopia, and Cities of Rwanda*, 2018.

34. Ibid.

Photo by Sincerely media on unsplash.com

not defining roads in an FRH are typically due to city administrators' traditional practice of viewing road networks in a physical way as mere cross-sections. Another common attitude involves requiring roads to serve all traffic functions, even incompatible ones in a potentially harmful mix of through traffic, local traffic, parking, trading, and walking functions.

Throughout Sub-Saharan Africa, there is poor public provision for Non-Motorized Transport (NMT). Walking is a major transport mode and the trip modal split for walking is high due to issues of land use, poverty, and lack of alternatives. Walking trips are long and walking typically does not provide an individual with status. In fact, pedestrians are seen as marginal. The reasons for this are manyfold but have their roots in the culture of rapidly developing cities where motorized transport is viewed as progress and cars are seen as desirable acquisitions, especially where there is poor availability of PT. For example, in Addis Ababa, Ethiopia, a study estimated that 54 percent of all trips were walking trips but only 35 percent of the road network had footways.[35] There is no segregation for pedestrians from motor vehicles, and footways and street lighting are poor. Even when footways are available, they tend to be occupied by parked vehicles or traders. Pedestrians are forced to walk on the roadway and mingle with motor vehicles, exposing them to danger and inconveniences. There are few safe signalized crossings for pedestrians to cross busy carriageways. Therefore, a need exists to develop pedestrian and NMT measures by adopting a people-centric approach that shifts the focus away from motorized modes.

There are no comprehensive parking management systems in existence and the window of opportunity to use parking as a Transport Demand Management (TDM) measure is in danger of being lost. Similar to many cities in developing countries worldwide, parking in Sub-Saharan African cities is a problem that has not been tackled.[36] This could be due to the lack of institutions responsible for parking but also the "bottom-up" evolution of informally managed public parking where footways are used to park vehicles to the detriment of pedestrians. Parking is typically managed informally through small, unofficial local entities that control footways, road space, and off-street spaces. For instance, most Nigerian cities have parking policies that are not at the top

35. SSATP Africa Transport Policy Program/Transitec, Final Report: *Sustainable Mobility and Accessibility Policy in Cities of Ethiopia*, October 2018.

36. SSATP Africa Transport Policy Program/Transitec, *Final Reports: Sustainable Mobility and Accessibility Policy for Kenya's Cities, Urban Areas of Ghana, Urban Areas of Nigeria, Cities of Ethiopia, and Cities of Rwanda*, 2018.

of the local agenda and there is limited interest in tackling highly concentrated parking demand in the country's monocentric cities. In Addis Ababa, Ethiopia, uncontrolled and illegal on-street parking, and overuse of road space by parked vehicles cause congestion and vehicle crashes which seriously affect the urban mobility system. In Nairobi, Kenya and in Nigerian cities, vehicles park on-street all day for free or a low fee; this Private Non-Residential (PNR) parking is used by commuters resulting in no parking turnover. In the Ghanaian cities of Accra, Kumasi, and Takoradi, on-street parking reduces road space for moving traffic and congestion is caused by vehicles moving in and out of parking spaces; parked vehicles spill over onto the road verges, bicycle lanes, and footways. Designated parking for paratransit is lacking in most cities and paratransit services occupy already congested road space while waiting for passengers. In several cities including Abidjan, Bamako, Dakar, and Tunis, cars park on the footway which should be reserved for pedestrians. It is rare to find parking regulations applied in these cities.

On-street implementation and enforcement of measures are poor and uncoordinated. The implementation of traffic management measures is difficult to achieve due to fragmented institutional arrangements. Such measures typically involve the coordination of traffic facilities such as road and footway surfacing upgrades, traffic signs, road markings, and barriers, together with equipment such as traffic signals and monitoring and enforcement cameras. A lack of funds and good design often results in poor solutions which bring reform measures into disrepute. Sustaining the effect of these traffic facilities through enforcement is also deficient due to a lack of enforcement staff such as traffic police and a sound legal structure for traffic regulations, and a public culture of disregarding traffic regulations.

Unreliable road safety data. Reliable road safety data are often lacking and tends to show an erroneously high percentage of accidents being caused by drivers' errors. Data are often collected by untrained police officers and local officials without proper expertise. There are many road safety initiatives in Sub-Saharan Africa but these tend to focus on rural and inter-urban roads such as the Global Road Safety Facility (GRSF) collaboration with the Federal Road Safety Corps (FRSC) of Nigeria in 2008 which significantly reduced road crash fatalities.[37] There is scope to utilize the Safe System approach[38,39] which requires shifting responsibility from those using roads to those designing them. This approach is based on the principle that errors are inevitable, but traffic fatalities and serious injuries should not be. The road system should be designed so that human error does not have a serious or fatal outcome.

Benefits from international experience have not been realized. Sub-Saharan African cities have gained little benefit from good international practice, the "tactical urbanism" of developing cities, or the "latecomer advantage" (see more in Chapter 7) of Intelligent Transport Systems (ITS).

Poor traffic demand forecasting. There is a lack of traffic modeling based on reliable data and this can result in a "predict and provide" approach. In other words, data on the growth of vehicle ownership and vehicle trip rates are typically used to justify new road construction rather than traffic management measures which can make the best use of the existing road network.

No Traffic Impact Analyses (TIA). There is no application of TIAs which can provide the basis for traffic management in cities. A TIA is normally carried by developers who must provide assurances to city authorities demonstrating that the traffic impact of a new development can be handled. In many countries, a TIA is a requirement and it provides a foundation for good traffic management practices. In addition, city authorities usually have requirements to fulfill regarding parking standards, servicing bays and access to the main road network.

37. GRSF (Global Road Safety Fund), The World Bank Group, Global Road Safety Facility: Leveraging Global Road Safety Issues, 2016.

38. World Resources Institute (WRI), GRSF (Global Road Safety Fund), Embarq, World Bank, Sustainable and Safe: A Vision and Guidance for Zero Road Deaths, 2018.

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3.

TECHNICAL NOTE ONE

GUIDELINES FOR STRENGTHENING INSTITUTIONS FOR TRAFFIC MANAGEMENT

- *Developing new practices within existing institutional structures and rationalizing their functions.*
- *Building on institutional structures with Cape Town, Addis Ababa, and Kigali as models.*
- *Two scenarios for reforming the traffic police.*
- *Knowledge transfer and capacity building.*

ENABLING stronger institutions for traffic management at the national, regional and city levels involves implementing a comprehensive range of measures. Any proposals for new or reformed institutions need to account for cultural issues, the power of key stakeholders in the countries concerned, and be sustained by the country without external support. This is a long-term program that needs to be continued over several years and is typically outside the timeframe of many urban transport projects or infrastructure programs.[40]

Deploying traffic management is not necessarily a simple solution. Such techniques and measures still require an institutional framework. In many cases, it is not clear which city or national agency is responsible for traffic management. This disconnect can be seen in Table 3.1 which presents a government matrix of traffic management institutions in selected Sub-Saharan African cities.

As can be seen from Table 3.1, the institutional arrangements for traffic management in Sub-Saharan African cities take a variety of forms. Policy, strategy, and planning functions tend to be at the ministry level. For traffic management, this high-level institutional arrangement may not be the most effective as the reality of traffic management thrives at the regional or city level and can benefit from policies tailored by a city for its own unique circumstances. For example, this region/city-based model evolved in the UK with Transport for London[41] and Transport for West Midlands,[42] and in Singapore with its Land Transport Authority.[43] Although these institutions are focused on Public Transport (PT) and promoting Non-Motorized Transport (NMT), they cover policy and planning for traffic management.

Institutional gap. Traffic management measures often fall into an "institutional gap" (broad public institutional deficiencies) in which TM techniques and measures are unable to meet the minimum requirements known as the "Three Es":

- **Engineering.** On-street physical engineering features such as curbs, dropped curbs (ramps), junction channelization islands, pedestrian refuge islands, barriers, bollards, signs, and road markings.
- **Education.** Sustained and targeted educational measures such as media campaigns, on-street campaigns, road safety education in schools, and Road User Education (RUE) for specific groups.
- **Enforcement.** Enforcement measures, typically the purview of the traffic police but increasingly the responsibility of civilian traffic wardens, especially for parking.

40. Barrett, Richard, Institution Building for Traffic Management WTP8, Urban Development, Technical Paper Number 8, The World Bank, January 1983.

41. https://tfl.gov.uk/ accessed 20 January 2021.

42. https://www.tfwm.org.uk/ accessed 20 January 2021.

43. https://www.lta.gov.sg/content/ltagov/en.html accessed 20 January 2021.

Table 3.1:
Governance Matrix for Traffic Management Institutions in Selected Sub-Saharan African Cities[44]

Level	Sector	Ethiopia		Kenya	Nigeria		Ghana	Rwanda
		Addis Ababa	Secondary Cities	All Cities	Lagos State	Abuja	Accra	Kigali
STRATEGIC: ***What strategies with what resources?***	Policy and planning (federal)	TMA	MoT	MoTIHUD	FMoW/ FMoT *but not defined;* LASMoT	FMoW/FMoT *but not defined;* FCTA Transport Secretariat	Ministry of Roads and Highways	City of Kigali and RTDA *but not defined*
	Policy and planning (regional)		Region & municipality TD					
	Funding	Municipal budget and loans	Municipal budget and loans	Consolidated fund; roads fund for maintenance	LASMoT	FCTA/Private	Ministry of Finance	
TACTICAL: ***What services should be developed and how to go about it?***	Regulation	MoT	MoT	Traffic police	LASTMA	FCTA *but not defined*	DUR, GHA, MMDAs *but not defined*	MININFRA and police
	Infrastructure, equipment	TMA	Region & municipality TD	KURA	FMoW	FMoW	GHA, DUR	City of Kigali
OPERATIONAL: ***How to enable efficient services?***	Operations, maintenance	TMA	Region & municipality TD	KeNHA, KURA and counties	FMoW *but not defined*	Directorate of Road Traffic Services (FCT)	MTTD	City of Kigali
	Enforcement*	Traffic police	Traffic police	Traffic police	Traffic police	Traffic police	Traffic police	Traffic police

* **Note:** It is assumed that the city traffic police are responsible for on-street enforcement of the traffic regulations but that the main part of their duties is to direct traffic at selected junctions during selected peak hours.

Developed cities in the UK, Europe and Asia tend to be concerned with city management such as green policies which focus on PT, NMT and the reduction of carbon emissions, as well as social equity through increased mobility and accessibility for all sectors of society. An institutional focus on these issues has evolved partly due to a need to develop PT. These cities also have access to sufficient resources through general taxation, road and vehicles taxes, and congestion and parking charges.

Contrary to the case for developed cities, rapidly growing cities in developing countries are typically focused on maintaining mobility and reducing ever-present congestion within economic, political, and environmental constraints. Their objectives are hindered by the lack of financial resources and professional expertise, however. Challenges like these can be seen in numerous Sub-Saharan African cities. For example, the traffic police who are responsible for traffic enforcement and clearing congestion do not have the public status or the resources to enforce traffic regulations fairly and honestly.

Funding and resources for Traffic Management (TM). Often TM is seen as the poor relation to large infrastructure schemes and new road construction. Decision-makers typically want to see high-profile projects completed within their political terms and TM can be a low priority on their agenda. TM schemes involve a variety of interventions that may be the responsibility of different agencies. For example, physical construction may be under the purview of a construction department, with signs and road markings being the responsibility of another agency. ITS is a different matter altogether and will be explored later in this document.

44. Africa Transport Policy Program (SSATP)/Transitec. *Final Report: Sustainable Mobility and Accessibility Policy in Cities of Ethiopia*, October 2018

DEVELOPING NEW INSTITUTIONAL STRUCTURES AND RATIONALIZING THEIR FUNCTIONS

There is no single model for an institutional framework for TM, and this is also the case for other sectors. Instead, each country needs to develop solutions customized for its own needs, technical capability, political system, and cultural influences.[45] The development of new institutions needs to focus on functions, with a clear demarcation between national/federal level functions and local functions to avoid duplication. A functional institutional framework for TM should consist[46] of the following factors:

- A national/federal level responsible for policies, strategies, standards, specifications and design manuals, legislation, ITS strategy, and policy.
- A local level responsible for planning, design, implementation, maintenance, local monitoring and evaluation, regulations, and enforcement.

There also needs to be a well-defined division between political and technical responsibilities and clear channels of communication between non-technical politicians and city leaders, and technical experts and transport professionals. As Barrett[47] has observed:

> *The responsibility of the technical agency is to provide the decision-makers with the information and data necessary for the formulation of policies and priorities and to implement and enforce the decisions that are made. ...The technical agency thus becomes the executive arm of the political body. This inter-relationship is necessary at both a national and local level."*

Given the different characteristics of Sub-Saharan African regions and the need to customize solutions tailored to each case, an institutional framework would likely be different for large and small countries depending on their area, population, population density, the extent of any large metropolitan areas, and the ratio of population in the largest and/or capital cities to the population of the whole country. Table 3.2 presents a range of data from selected cities in Sub-Saharan Africa, and it shows that institutions for cities in countries such as Nigeria, Ethiopia, and the Democratic Republic of Congo (DRC) with their large populations, areas and metropolitan areas could be different from those for Rwanda with its smaller cities. To help develop a roadmap to better institutions, this table identifies a range of Sub-Saharan African cities in the context of city populations and the ratio of city population to country population. Table 3.2 starts an examination and comparison of transport institutions in Sub-Saharan Africa and explores the parameters for embedding traffic management functions in these institutions.

Given the different characteristics of Sub-Saharan Africa countries, these institutional frameworks would need to be customized for large and small countries. Larger countries generally have more layers of administration at the federal, state, regional and local levels, and functions can often be duplicated. With their limited resources and smaller urban traffic management areas, smaller countries have a need to consolidate functions into fewer agencies with a wider purview.

This is the case in large countries like Nigeria where road safety functions are fragmented. The paramilitary Federal Road Safety Commission (FRSC)[48] is responsible for road safety issues, issuing drivers' licenses and production of car number plates (but not vehicle licensing). However, the establishment of the FRSC in 2007 did not solve the governance issues for road safety where a myriad of agencies vie for control of road safety responsibilities. Furthermore, the FRSC's focus on operational matters - duplicating other agencies and often operating at cross purposes – has hindered its ability to be a strategic lead and inspiration in the road safety scene in Nigeria.[49] Other state level agencies, such as the Lagos State Traffic Management Authority (LASTMA) and the Motor Vehicle Administration Agency (MVAA) perform similar functions and often overrule each other.

45. Barrett, Richard, Institution Building for Traffic Management WTP8 Urban Development, Technical Paper Number 8, The World Bank, January 1983.

46. Ibid. Updated and refined by the author of this report tin 2021 to include ITS and other functions.

47. Barrett, Richard, Institution Building for Traffic Management WTP8 Urban Development, Technical Paper Number 8, The World Bank, January 1983.

48. https://frsc.gov.ng/ accessed 2 April 2021.

49. Sumaila, Abdul Ganiyu Femi, *Road crashes trends and safety management in Nigeria*, Department of Transport Management Technology, Federal University of Technology, Minna, Nigeria, 2013.

Table 3.2:

Population Statistics of Selected Cities in Sub-Saharan Africa[50]

Country	Country Population (million) 2021	Metropolitan Areas and their populations (million) 2021 data	Ratio of the population of capital (or largest) city to country population	Ratio of the population of the second largest city to the capital city/largest city
Large countries				
Nigeria	211.40	• Lagos (14.86) • Kano (4.10) • Ibaban (3.65) • Abuja (3.46) • Port Harcourt (3.17) • Benin City (1.78) • Onitsha (1.48) • Uyo (1.20) • Kaduna (1.13) • Aba (1.11)	Lagos (7%) Abuja (2%)	Kano to Lagos (28%) Abuja to Lagos (23%)
Ethiopia	117.88	• Addis Ababa (5.01) • Dire Dawa (0.43)	Addis Ababa (4%)	Dire Dawa to Addis Ababa (9%)
DR Congo	92.38	• Kinshasa (14.97) • Mbjui Mayi (2.64) • Lubumbashi (2.58) • Kananga (1.52) • Kisangani (1.31) • Bukava (1.13)	Kinshasa (16%)	Mbjui Mayi to Kinshasa (18%)
Tanzania	61.50	• Dar es Salaam (4.36) • Mwanza (1.18) • Dodoma (0.26)	Dar es Salaam (7%) Dodoma (0.42%)	Mwanza to Dar es Salaam (27%)
South Africa	60.04	• Johannesburg (5.93) • Cape Town (4.71) • Bloemfontein (0.55) • Pretoria (2.38) • Ekurhuleni (3.97) • Durban (3.18)	Johannesburg (10%) Cape Town (8%)	Cape Town to Johannesburg (79%) Ekuhuleni to Johannesburg (67%)
Kenya	54.98	• Nairobi (4.92) • Mombasa (1.34)	Nairobi (9%)	Mombasa to Nairobi (27%)
Uganda	47.12	• Kampala (3.47) • Gulu (0.15)	Kampala (7%)	Gulu to Kampala (4%)
Small countries				
Senegal	17.20	• Dakar (3.23) • Pikine (0.87)	Dakar (19%)	Pikine to Dakar (27%)
Zimbabwe	15.09	• Harare (1.54) • Bulawayo (0.70)	Harare (10%)	Bulawayo to Harare (45%)
Rwanda	13.27	• Kigali (1.17) • Huye (0.09)	Kigali (9%)	Huye to Kigali (8%)
Sierra Leone	8.14	• Freetown (1.24) • Bo (0.17)	Freetown (15%)	Bo to Freetown (14%)

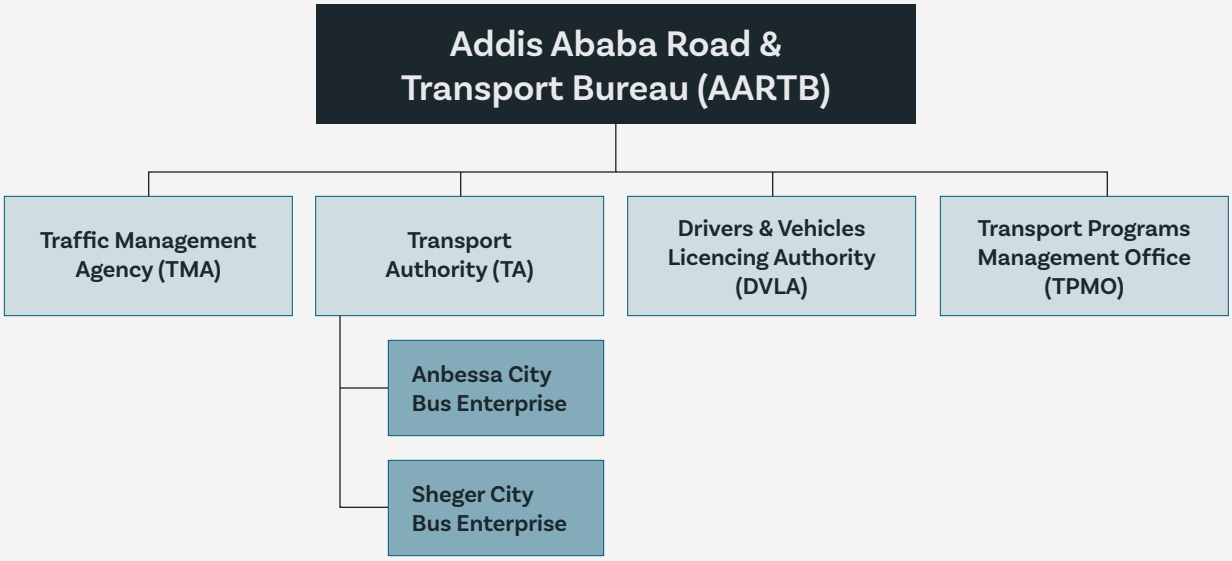
50. https://worldpopulationreview.com/world-cities accessed 2 April 2021

BUILDING ON INSTITUTIONAL STRUCTURES WITH CAPE TOWN, ADDIS ABABA, AND KIGALI AS MODELS

International institutional model for Cape Town embeds traffic management in a comprehensive structure. The legislative capital of South Africa, Cape Town, has an institutional structure modeled on London, UK[51] and other international cities. Cape Town's Transport Directorate, or Transport for Cape Town,[52] has consolidated a comprehensive range of functions including transport and urban development policy and planning, transport infrastructure investment programs, network operations and management, PT, financial management, regulations, and enforcement. Traffic management functions are embedded within this framework, reflecting the fact that traffic management is part of most transport infrastructure and operations. This enabled Cape Town to develop and promulgate a traffic calming policy in 2016, a freight strategy in 2016, a transport demand strategy in 2018, and a parking policy in 2020, all within the context of the city's Comprehensive Integrated Transport Plan (CITP), 2013 – 2018.[53]

Building on existing institutional structures with Addis Ababa as a model. The case of Addis Ababa, Ethiopia can provide a possible roadmap for other cities to emulate. Here, the city itself has responsibility for most traffic management functions from policy and planning, funding, regulation, infrastructure, equipment, operations, maintenance, and enforcement, with the traffic police having minimum responsibilities under the first scenario for reforming traffic police (see "traffic police are responsible only for enforcement" section of this document) while focusing only on enforcement. In Addis Ababa, their Traffic Management Agency (TMA) oversees policies "reducing congestion and emission levels as well as improving road safety"[54] in the city. The TMA also carries out Road User Education (RUE) campaigns with road crash victims,

FIGURE 3.1:
Addis Ababa Road and Transport Bureau Organizational Chart[55]



51. https://tfl.gov.uk/ accessed 25 April 2021.
52. https://www.tct.gov.za/en/home/ accessed 25 April 2021.
53. Transport and Urban Development Authority (TDA) Cape Town, 2013 – 2018 Comprehensive Integrated Transport Plan, 2015.
54. Africa Transport Policy Program (SSATP)/Transitec. Final Report: *Sustainable Mobility and Accessibility Policy in Cities of Ethiopia*, October 2018.
55. Email correspondence with Wenyu Jia, The World Bank, April 2021.

women's associations, churches, and schools. Figure 3.1 shows how the TMA comes under the umbrella of the Addis Ababa Road and Transport Bureau and how it has horizontal connections to the transport authority (for coordination with PT operations), the driver and vehicle licensing authority, and the office responsible for managing transport programs.

Institutional reform in the TRANSIP Project, Addis Ababa. The World Bank-funded Transport Systems Improvement Project (TRANSIP) in Addis Ababa, Ethiopia commenced operations in 2016. It is the first project in Sub-Saharan Africa to create significant proposals for traffic management as well as institutional development. The project is comprised of three components:

- Traffic management and road safety
- Improvement of the integrated urban planning and transport system
- Road safety interventions and strengthening of selected federal transport institutions

The project's goals are to improve urban transport performance and governance in Addis Ababa, and to modernize key national level vehicle, licensing, and driver training systems. Part of the project's institutional brief aims to rationalize functions between national level federal agencies (such as the Federal Traffic Police) with municipal level agencies (Addis Ababa Traffic Police Department) to avoid duplicating functions.

The TRANSIP project focuses on deploying an Integrated Corridor Management (ICM) approach on five major road corridors (see also Figure 4.6 and a section in Chapter 4 on how road sections can be categorized) in Addis Ababa, and on improving national institutions to ensure compliance with road traffic laws. Embedded in the three main components are the following institutional reform proposals:

- Strengthening the capacity of the TMA to carry out its assigned responsibilities including designing and implementing appropriate traffic management measures and related training.
- Improving traffic enforcement and traffic safety through the provision of equipment and traffic enforcement training for the Addis Ababa Traffic Police Department (see the section later in this chapter which describes two scenarios for reforming the traffic police).
- Strengthening institutional capacity by restructuring the Addis Ababa City Roads Authority (AACRA) which includes the development of a road asset management system, the deployment of a maintenance strategy, and the development of an improved road design manual and a road maintenance manual.
- Strengthening the capacity of associated agencies in the transport sector to better enable coordination and integration (including local agencies tasked with PT operations, urban planning, parking, and road safety, as well as federal agencies at the national level such as the Federal Traffic Police, the Ministry of Transport and the Ministry of Construction).

TRANSIP implementation is being carried out by Project Implementation Units (PIUs) which are comprised of staff from various agencies. It is envisioned that this arrangement will improve horizontal integration to enable better implementation of on-street improvement measures. While implementation has been delayed by the 2020 Covid-19 pandemic, on-street measures for the first corridor in the ICM component are designed and ready to be implemented this year. Over the past six years, the agencies scheduled for reform have demonstrated steady capacity development and their staff have been attending training courses in South Africa on Information Technology (IT) applications. However, the slow pace of institutional reform has been vividly illustrated here in this project cycle. The key message of this process is that reforming institutions takes time.

In Kigali, traffic management has started to flourish within the framework of broader transport plans. The city government has a centralized yet local role in traffic management. Since 2007, Rwanda has pursued a policy of decentralization[56] which has increased local governments' responsibilities regarding land use and transport policy matters. The Rwandan government recognized that traffic management policy, planning, and implementation of reform measures would be best served at a city level within a broader regional or national framework.

56. Rwanda Decentralization-Centralization Strategic Framework, 2007: http://www.rgb.rw/fileadmin/Publications/Rwanda_Governance_Review/Rwanda_Governance_Review_2018.pdf accessed 24 April 2021.

This can be seen in Kigali, where traffic management measures have started to flourish under the Kigali Conceptual Master Plan of 2013 (KCMP).[57] The KCMP is providing an overall vision for the city to guide planning at local and district levels.

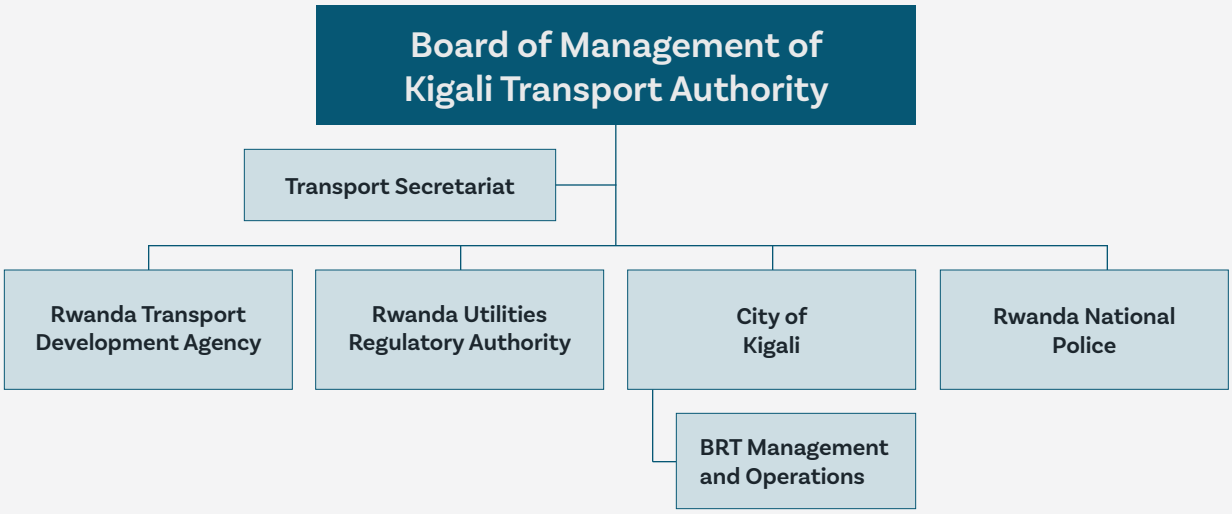
A key recommendation of KCMP is that traffic management should become a legislative priority in the city. Several tools such as transport impact assessments can be required for planning approvals, where traffic studies will guide the approval of projects within the city, especially within the commercial core.

Furthermore, the updated Kigali Transport Master Plan (KTMP) of 2018[58] provided a framework for the long-term development and expansion of existing transport systems. The KTMP presents long-term strategic and network improvement plans for a design horizon as far away as 2050, while preparing intermediate plans for short-term implementation. The KTMP also identifies several areas for transport improvement including becoming a transit-oriented city; establishing a comprehensive transportation system; and creating a sustainable transportation network.

While it has no specific plan for traffic management, the Green Transport Network Strategy of the KTMP recommends that the city of Kigali be responsible for traffic management planning, policy, and funding as well as the development, implementation, and maintenance of traffic management measures.

For urban mobility planning, there is a particularly strong system of inter-governmental relations between central government agencies, the City of Kigali, and the provincial and district levels of government. Political commitment is expressed through coordination between the following relevant agencies: The City of Kigali which has a leading role in planning; the Roads and Transport Development Agency (RTDA); the Ministry of Infrastructure (MININFRA); and the Rwanda Utilities Regulation Agency (RURA) as shown in Figure 3.2.

FIGURE 3.2:
Kigali, Rwanda, Institutional Framework for Transport[59]



57. Kigali Comprehensive Master Plan (KCMP), 2013:*http://www.masterplan2013.kigalicity.gov.rw/downloads/Docs/RWF1101_04_Kigali%20Transportation%20Ma ster%20Plan_04062013-s.pdf* accessed 12 February 2021.

58. Kigali Transport Master Plan (KTMP), update 2018: *https://bpmis.gov.rw/asset_uplds/kigali_master_plan/3_Kigali%20Master%20Plan_Transport%20PlanLowRes.pdf* accessed 24 April 2021.

59. Ibid.

In Kigali, there is clearly defined coordination between the agencies with traffic management responsibilities as shown in Table 3.3 and referred to in Table 3.1 where Kigali can be compared with other Sub-Saharan African cities.

The institutional models of Addis Ababa and Kigali show two possible structures in which traffic management can operate, illustrating the difference between large and small countries and large and small cities. Addis Ababa has a population of 5.01 million comprising four percent of Ethiopia's overall population of 117.88 million; Kigali has a population of 1.17 million comprising nine percent of Rwanda's overall population of 13.27 million. In both institutional structures, traffic management is under each city's authority. With its small percentage of Ethiopia's total population, Addis Ababa has a TMA on the same level with other city agencies responsible for PT, the licensing of drivers and vehicles, and the development of transport programs. The rural nature of most of Ethiopia is reflected in the fact that traffic management functions are focused on the cities with a limited current requirement for a national remit. In Kigali, it makes sense to integrate city functions with national ones due to the high percentage of Rwanda's population living there. Here, most traffic management functions are centralized under city management which is on a par with national agencies such as the Rwanda Transport Development Agency (RTDA), the Rwanda Utilities Regulatory Authority (RURA), and the national police.

Table 3.3:
Kigali, Rwanda, Traffic Management Institutional Framework

Sector	Some illustrative examples of responsibilities within the sector	Responsible Institution
Transport Policy and Planning (Federal)		City of Kigali and RTDA
Transport Policy and Planning (Regional)		City of Kigali and RTDA
Funding for Transport	• From central and local government funds • From traffic penalties	City of Kigali and RTDA
Regulation of Transport	• Developing the traffic regulations • Enshrining the traffic regulations in law • Enforcing the traffic regulations through on-street staff presence and through E-police enforcement cameras • Management of traffic penalties	MININFRA and the Police
Infrastructure and Equipment	• Design of traffic management schemes • Design of traffic calming schemes • Traffic management for PT and NMT • Design and procurement of on-street Intelligent Transport Systems (ITS) and centralized equipment for the Traffic Command Center (TCC)	City of Kigali
Operations and Maintenance	• Implementation of junction channelization and other physical measures such as road humps • Installation of traffic signs, road markings and barriers • Installation of traffic signals and other on-street Intelligent Transport Systems (ITS) • Operation of the TCC	City of Kigali
Parking	• Parking management strategy • Parking planning: zoning, location, pricing • Regulation of on-street and off-street parking • Devolution of parking management and operations to enterprises	City of Kigali

Institutions for Intelligent Transport Systems (ITS). ITS present a different case for the institutional framework to be at the national or ministry level. They are part of a rapidly expanding technological revolution that is not just concerned with transport but with ensuring ubiquitous connectivity throughout citizens' lives and livelihoods. "Smart Mobility" is embedded in "Smart City" initiatives (see Chapter 7) and is generally better managed at a higher level as can be seen in China with the establishment of its Ministry of Industry and Information Technology.[60]

Coordinating with other agencies. Any agency responsible for traffic management at the national, regional and city levels needs to coordinate with other agencies, otherwise the traffic management sector will operate in a silo with the risk of resource duplication and poor outcomes. The type of coordination should be reticulated or horizontal rather than vertical so that decisions can be made quickly and matters do not have to travel up the institutional hierarchy to the top decision-maker in one agency then back down again to those responsible for implementation in the next agency.

The key areas for coordination include the following:

- Urban development strategic planning
- Transport planning
- Urban infrastructure development, design and implementation
- Public transport agencies for PT operations
- Road safety agencies (together with health agencies for confirmation of road safety data from hospitals) and road crash database
- Law enforcement agencies
- Agencies responsible for national and local ITS strategy, development, design, and deployment
- Police and traffic police
- Driver and vehicle licensing databases

Photo by Confident G. Ntwarane on unsplash.com

60. http://english.www.gov.cn/state_council/2014/08/23/content_281474983035940.htm accessed 20 January 2021.

TWO SCENARIOS FOR REFORMING THE TRAFFIC POLICE

Reforming the traffic police is an institutional change that could be realistically achieved in the short to medium term. Stronger institutions need to be properly resourced with sufficient and sustained funding. For traffic management, this means more funding for the traffic police which could include better salaries for employees. This would contribute to improving the public status of the traffic police who are the public face of traffic management in many cities.

This report presents two scenarios for traffic police engagement in traffic management gleaned from experience in developed countries. The first scenario envisions a minor role for the traffic police in enforcement only. The second scenario envisions a broader role with the traffic police becoming involved in traffic engineering and the design and development of ITS.

The main function of the traffic police is enforcement of the traffic regulations. Yet the traffic police could be replaced by civilian wardens and traffic violations could be decriminalized. This is recommended for parking enforcement but could be extended to general traffic violations, especially with E-police camera enforcement where the ultimate objective is to have zero violations. Citations for traffic violations should not be viewed as a revenue generating activity for the police or other agencies. The traffic police should direct the revenue from traffic violations to a centralized point where it is ring-fenced for transport improvements. It is not likely that this type of system is prevalent in many Sub-Saharan African cities.

As stated before in this section, the public face of institutional traffic management is the traffic police and many questions remain about their role in society. How significant should their role be and how much power should they have? To what extent are the traffic police resourced? Are the traffic police respected in society and do they have a positive status? In the following two scenarios for traffic management institutions, the traffic police should not only be fully resourced and respected by the public but they should also have significant yet defined roles to play. These scenarios are at either end of a spectrum of possibilities: in the first scenario, the traffic police have minimum responsibilities and in the second, they have maximum responsibilities.

Scenario 1: Traffic police are responsible only for enforcement. This scenario is seen in Europe, the UK, and some Asian cities (Singapore, Hong Kong, Seoul). The traffic police are only responsible for enforcing the traffic regulations and for clearing incidents, crashes, and congestion. They are consulted on the development of traffic management schemes and generally have input on operational and enforcement designs.

For ITS operation and enforcement, the traffic police have their own Traffic Command Center (TCC), which connects with and mirrors the main TCC which is staffed by a transport/roads department or authority. The increasing use of electronic enforcement by cameras (E-police enforcement) releases the traffic police from humdrum duties and enables them to focus on more serious crimes. These E-police cameras have Automatic Number Plate Recognition (ANPR) and are linked to national driver and vehicle databases to issue fines for traffic violations. The databases are typically managed by other government entities as opposed to the traffic police.

In this scenario, institutions are not siloed and there is cross-coordination between agencies whereby decisions can be made at lower levels with greater horizontal connectivity. There is minimal reticulation where a vertical institutional structure requires decisions to travel up the hierarchy to the top within one siloed institution, bridge across to the top of another siloed institution, then move down the hierarchy of the other institution.

The responsibility for ITS development is within the transport/road authority, typically at a city or regional level but also in the context of a national framework. ITS encompasses more than traffic management interventions; it also includes Public Transport (PT) operations and city-wide safety and security.

The traffic police are not the armed police and are not part of the military; they are part of a national police force and coordinate with other police activities in tracking criminals. For example, ANPR, E-police cameras and CCTV cameras can be used to track and catch criminals, but their main functions are for traffic purposes.

The traffic police also have a role to play in Road User Education (RUE) by spearheading and running campaigns and outreach to targeted groups such as schoolchildren.

Scenario 2: Traffic police are responsible for more than enforcement. This scenario is seen in China and Japan. The traffic police are responsible for more than enforcement and are key players in the development, design, and implementation of traffic management schemes. This involves coordination with municipal construction agencies to install physical works such as junction channelization -- the coordination of these works with the installation of other equipment such as traffic signals can be problematic. In this scenario, the traffic police are key players in the development and deployment of ITS, using such systems not just for enforcement but for non-traffic purposes such as criminal tracking, data collection and analysis, and transport modeling.

In this scenario, institutions tend to be more siloed and thus can hamper decision making. However, a powerful traffic police department can typically take the lead in advancing traffic management schemes and ITS.

The responsibility for ITS development is within the main police department, not just the traffic police. The transport elements of ITS are merely a small part in the evolution of ITS in Asian cities, where smart cities, Big Data (see Chapter 7), and lack of data privacy can be a part of normal life.

While the traffic police have a role in RUE as in Scenario 1 (traffic police are responsible only for enforcement), they are more closely related to the armed police (in some countries the traffic police are armed) and the military but can be separate entities within quasi-military structures. There is closer coordination between the traffic police and other police in this scenario compared to the first scenario. In this scenario, the traffic police are more firmly embedded in national police institutional structures, and the difference between the traffic police and other police forces can be marginal. Also, in this scenario, tracking of criminal activities can be part of their primary duties using E-police enforcement cameras with ANPR as well as facial recognition.

The functions of the traffic police could be clarified by developing a useful roadmap to improve their institutions. Should the traffic police just focus on enforcement or do they have a role in other elements of traffic management such as traffic engineering design, ITS, and road safety? City governments could consider enhancing the status of the traffic police by:

- Professionalizing the occupation and ensuring that employees are competent at their job.
- Ensuring fair recruitment practices for employees who are qualified for the job.
- Developing a career path (this could be within the traffic police or within the overall policing system).
- Expanding training activities including regular refresher training and training in traffic management.
- Providing regular health checks.
- Ensuring safe on-street work (linked to road and street design) through training and the provision of protective and high-visibility equipment.
- Monitoring their performance.
- Embracing new technology in communications, databases, and taking the "latecomer advantage" (see Chapter 7).
- Allocating more local and national resources for the traffic police.
- Paying better salaries to reduce the temptation of dishonesty and exploitation of citizens.

KNOWLEDGE TRANSFER AND CAPACITY BUILDING

The "institutional gap" mentioned in Chapter 2 under "poor institutional framework for traffic management" and Chapter 3 under "institutional gap" is further compounded by the lack of expertise of local personnel and the dearth of transport professionals who are knowledgeable of the broad nature of traffic management and its potential. In Sub-Saharan Africa, traffic management education has focused on training traffic police and enforcing traffic regulations. This is evident in South Africa, for example, where national agencies provide this service[61,62] along with several municipalities.[63] There is little professional training at Sub-Saharan universities where the emphasis in the urban

61. https://www.hjntraining.co.za/index.php/qualifications/national-certificate-traffic-management accessed 4 April 2021.

62. https://www.rtmc.co.za/index.php/what-we-do/training/training-and-development accessed 4 April 2021.

63. For example: Matjhabeng Traffic Training College in Welkom, Free State, South Africa, Cape Town Metro Police Department Academy, Western Cape, South Africa.

transport academic and professional sector is on civil and highway engineering.[64] As of the early 2020s, traffic management skills still need to be brought into Sub-Saharan African countries through international consultants and firms with international expertise.

Indeed, Sub-Saharan Africa today is no different from the situation in the 1980s in the UK, Europe, the US, and Asia, where traffic engineering and traffic management were seen as a small side-line to civil engineering where students might specialize at the MSc level as an afterthought. This situation has undergone radical change over the past 30 years outside Sub-Saharan Africa and now traffic management courses at these universities are offered as discrete courses. Students can study a wide range of traffic management related themes including the following: traffic engineering, road safety, ITS, micro-simulation and modeling techniques for traffic management, PT management and operations, environmental management, parking, and Transport Demand Management (TDM). These courses are all complementary to traditional civil engineering practices.

In Sub-Saharan Africa, training in traffic management (other than police enforcement) is not part of the curriculum and the cost of international training is cost-prohibitive. There is scope to build on the excellent civil engineering courses available at many of the premier universities in the continent and expand these courses to encompass traffic engineering and traffic management. This could start with a series of pilot short courses for post-graduates and expand to encompass full-time permanent courses which would typically show results after four or five years. These include the Center for Transport Development in Pretoria;[65] the Kwame Nkrumah University of Science & Technology, Kumasi, Ghana[66] with its Master of Science program in sustainable transport, transport engineering and transport planning; the University of Nairobi in Kenya; and the Universities of Kwazulu-Natal, Witwatersrand, Pretoria, Stellenbosch, and Cape Town in South Africa.

Consistent with traffic management courses at universities, this report recommends the practice of *counterpart working and on-the-job training* with local personnel partnered with international experts at a technical level. Finally, decision-makers such as city mayors need to see the benefits of traffic management as opposed to large infrastructure projects; one of the best ways of doing this is to organize *international study tours* for local leaders and technical officers so they can directly experience the benefits of traffic management measures for themselves. Although criticized by some, study tours nevertheless can be catalysts for radical change in developing countries because the participants are often persuaded to become champions for traffic management during the experience.[67]

Another knowledge transfer option to pursue consists of embedding professional staff from Sub-Saharan African cities in an international agency such as the World Bank. This would typically last for one year. Cape Town has benefitted greatly from this initiative, with the current acting commissioner for urban transport and development using the experience and insight gained from a one-year placement at the World Bank to see the potential for different international solutions. This quote from the Cape Town beneficiary aptly sums up the benefits of this approach:

> ***"African cities are very different in terms of transport. I knew that in theory, but I got exposed to that working with the World Bank as I started engaging with my colleagues in South America and elsewhere..... Now, I have this toolkit of solutions..... We have to see which one fits best and how to put the narrative together to solve the problem."***[68]

Strengthening local institutions through innovative data collection. In Sierra Leone, the World Bank's Integrated and Resilient Urban Mobility Project (IRUMP) is strengthening the capacity of local institutions in transport, in particular the civil engineering program of Freetown's Fourah Bay

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64. https://www.bachelorstudies.com/Bachelor/Civil-Engineering/Africa/ accessed 4 April 2021.

65. https://www.up.ac.za/center-for-transport-development accessed 1 April 2021.

66. https://www.knust.edu.gh/ accessed 1 April 2021.

67. For example, international study tours to Europe and Asia from Wuhan clients of the Wuhan Second Urban Transport Project, (P112838), 2010 - 2018, where expertise and experience in Intelligent Transport Systems (ITS) and physical junctions channelization and road tables was implemented in Wuhan.

68. Gershwin Fortune, Acting Commissioner for Urban Transport and Development, speaking in 2019, https://cities-today.com/getting-transport-back-on-track/ accessed 24 April 2021.

Table 3.4:
Traffic Management Functions and an Effective Institutional Framework

TM Function	Most Effective Agency	Activities
Policy/Strategy	• Transport planning authority at the national/federal/state/ regional/city level	• Principles of traffic management • Objectives of traffic management (safety and efficiency) • Complementing and essential to new road construction • Focus on specific transport modes (e.g., cars, trucks, buses, NMT, vulnerable modes)
Planning	• Transport planning authority at the national/federal/state/ regional/city level • Legal authority	• Establishing the legal basis for traffic management enforcement • Promulgating traffic regulation orders in law • Setting up in law the fines and penalties for traffic violations
Development and design of TM schemes and measures	• Regional/city transport or roads department • Traffic management section • Design institute • Consultants	• Development and design of area-wide TM schemes, and specific stand-alone measures • Consultation and coordination between government agencies • Public consultation
Engineering: Implementation of TM schemes and measures	• Regional/city transport or roads department • Traffic management section • Construction department of city government • Construction company/ contractors	• Physical construction (curbs, junction channelization, textured and colored surfacing) • Traffic facilities (signs, road markings, barriers, bollards) • Monitoring and evaluation • Replication city-wide for successful measures
ITS policy, strategy, planning and development	• National/ministry level with a bespoke agency	• Objectives • Smart cities and smart mobility • Data privacy • Data integration and Big Data • Specifications and functions • Hardware and software development
ITS design and implementation	• Regional/city transport or roads department • Traffic management section • Design institute • Consultants • Traffic police	• Equipment procurement • Installation and adoption of on-street and Traffic Command Center (TCC) equipment • Communications; smart phone connectivity through apps • Complementary physical design • Monitoring and evaluation
Development of Road User Education (RUE)	• Regional/city transport or roads department • Traffic management section • Traffic police • Road safety agency	• RUE campaigns and programs with targeted messages to targeted groups • RUE materials • Monitoring and evaluation of RUE
Enforcement of traffic regulations	• Traffic police • Civilian traffic wardens	• On-street enforcement • E-police camera enforcement • Management of fines

Photo by Michael Muli on unsplash.com

College (FBC).[69] As an evolving innovation hub in West Africa, Sierra Leone is utilizing the talent and enthusiasm of youth, students at the FBC, and local citizens to help revolutionize urban mobility and create a local pool of qualified transport professionals. To find out how flooding impacted local transport services, the IRUMP collected mobile phone Call Data Records (CDR) along with data on flooding, poverty, transport supply and demand and compared it with information from the health, education, and tourism sectors. Although not designed specifically for traffic management, this innovative model could be applied in the traffic management sector to collect trip data for a range of transport modes including walking and two-wheeled vehicle trips, journey time, and time spent delayed in traffic congestion.

In summation, Table 3.4 illustrates the functions of traffic management institutions and indicates which agencies can deliver the most effective solutions. Horizontal coordination between departments and minimizing siloes of responsibility are crucial to traffic management. For smaller cities, transport functions can be consolidated in fewer institutions.

In addition, an Agency Responsibility Analysis (ARA) is a systematic approach developed by Barrett[70] which covers all aspects of the urban transport sector and the institutional environment in which traffic management takes place. Barrett's methodology was originally proposed for the World Bank project cycle, but it has a much broader relevance today. Barrett's approach has been updated to include recent innovations in traffic management such as ITS, TDM, traffic calming, parking and more. In an ARA, Table 3.5 would be filled in with the name of the relevant agency which would then be evaluated for its performance. Table 3.5 vividly illustrates the myriad of activities and functions which come under the umbrella of traffic management.

69. https://blogs.worldbank.org/transport/through-technology-and-creative-thinking-african-youth-are-reinventing-future-urban; https://blogs.worldbank.org/opendata/how-urban-mobility-data-transformed-freetown; https://blogs.worldbank.org/transport/africas-students-can-transform-future-transport-lets-invest-them-0 accessed 1 April 2021

70. Barrett, Richard, Institution Building for Traffic Management WTP8 Urban Development, Technical Paper Number 8, The World Bank, January 1983.

Table 3.5:

Principal Transport Functions and Responsibilities of a Traffic Management Agency at the National and Local Levels[71]

FUNCTION	NATIONAL LEVEL		LOCAL LEVEL	
	Primary Agency Responsible	Other Agencies Involved	Primary Agency Responsible	Other Agencies Involved
Formulating and Implementing Policies for:	X	X		
Urban Transport	X	X		
Public Transport	X	X		
Traffic Management	X	X		
Road Safety	X	X		
Intelligent Transport Systems (ITS)	X	X		
Big Data Integration	X	X		
Traffic Calming	X	X		
Transport Demand Management (TDM)	X	X		
Parking	X	X		
Formulation of the Traffic Regulations:				
Development				
Consultation				
Promulgation				
Formulating Standards and Specifications for Materials, Design, Siting, Operation and Maintenance of:	X	X		
Traffic facilities (signs, lines, barriers and bollards)	X	X		
Small civil works (junction channelization, road humps, road tables, curbs, dropped curbs, ramps, colored and textured surfacing, etc.	X	X		
Traffic signals and Area Traffic Control (ATC)	X	X		
Deployment of Traffic Facilities, Civil Works, and ATC:			X	X
Design			X	X
Procurement and Bidding			X	X
Implementation			X	X
Maintenance			X	X
Evaluation			X	X
Use of the Roadway and Footway by road users:	X	X		
Licensing, Regulation and Testing of Vehicles	X	X		
Licensing, Regulation and Testing of Drivers	X	X		
Vehicle Loading Regulations	X	X		
Setting of Speed Limits	X	X		
Assisting Local Agencies with Traffic and Transport Plans:	X	X		
Appraising plans	X	X		
Supervision implementation	X	X		
Monitoring and Evaluation	X	X		

71. Ibid. Updated and refined by the author of this report tin 2021 to include a wider range of functions.

Transport Projects:			X	X
Planning			X	X
Design			X	X
Implementation			X	X
Maintenance			X	X
Evaluation			X	X
Enforcement and Monitoring of the Urban Realm:			X	X
Vehicle Traffic			X	X
NMT			X	X
Road crashes			X	X
Vehicle Operating Costs			X	X
Parking Schemes:			X	X
Development of a Parking Management Strategy			X	X
Control of parking locations, number of bays and pricing			X	X
Design			X	X
Implementation			X	X
Management			X	X
Civilian enforcement			X	X
NMT facilities comprising facilities for pedestrians, bicycles, and e-bikes:			X	X
Footways			X	X
Pedestrian areas			X	X
Pedestrian crossings			X	X
Bicycle lanes and routes			X	X
Motorized two-wheelers			X	X
Management			X	X
Two-wheeler routes and lanes			X	X
Temporary Traffic Management during construction:			X	X
Guidelines and requirements			X	X
Temporary Traffic Management (TTM) schemes			X	X
Trucks and Heavy Vehicles			X	X
Loading and Weigh-In-Motion (WIM)			X	X
Truck routes			X	X
Transport of hazardous substances			X	X
Delivery regulations			X	X
Loading regulations			X	X
Road Safety and Crash Data Collection and Analysis:			X	X
Road safety database			X	X
Data collection and analysis			X	X
Development of remedial measures			X	X
Evaluation of measures			X	X
Coordination with Public Transport			X	X
Bus stops and BRT/Tram/LRT stations			X	X
Bus lanes and BRT			X	X
Crossing points			X	X
Knowledge Transfer, Capacity Building and Training in:	X	X		
Transport planning	X	X		
Urban and land use planning	X	X		
Traffic engineering	X	X		
Transport modelling	X	X		
Transport economics	X	X		

Photo by Yonko Kilasi on unsplash.com

Finally, a roadmap and timeframe for achieving a sound institutional framework for traffic management is provided in Table 3.6.

Table 3.6:
Roadmap and Timeframe for Institutional Development

EASI Framework	Traffic Management Institutional Potential	LEVEL	TIMELINE
ENABLE	**Establish better institutions for Traffic Management to ENABLE a strong institutional foundation.**		
1. Developing new institutional structures and rationalizing their functions.	An institutional framework for traffic management would comprise the following: • A national/federal level responsible for policies, strategies, standards, specifications and design manuals, legislation, ITS strategy and policy. • A local level responsible for planning, design, implementation, maintenance, local monitoring and evaluation, regulations, and enforcement.	STRATEGIC	LONG TERM
2. Building on existing institutional structures with Cape Town, Addis Ababa and Kigali as models.	• Cape Town: International institutional model embeds traffic management in a comprehensive structure. • Addis Ababa: The city itself has responsibility for most traffic management functions from policy and planning, funding, regulation, infrastructure, equipment, operations, maintenance, and enforcement, with the traffic police having minimum responsibilities. • Kigali: Traffic management has started to flourish within the framework of broader transport plans; the city government itself has a centralized, yet locally specific role in traffic management.	STRATEGIC	MEDIUM TERM
3. Developing Institutions for Intelligent Transport Systems (ITS).	ITS present a different case for the institutional framework to be at national or ministry level. ITS are part of a rapidly expanding technological revolution that is not just concerned with transport but with ubiquitous connectivity throughout citizens' lives and livelihoods.	STRATEGIC	MEDIUM TERM
4. Coordinating with other agencies.	The key areas for coordination include: urban development strategic planning; transport planning; urban infrastructure; PT; road safety agencies; law enforcement agencies; ITS; police and traffic police; driver and vehicle licensing database.	STRATEGIC	MEDIUM TERM
5. Examining two scenarios for reforming the traffic police.	The first scenario envisages a minor role for the traffic police in enforcement only; the second scenario envisages a broader role with the traffic police becoming involved in traffic engineering and design, and ITS.	STRATEGIC	MEDIUM TERM
6. Enabling knowledge transfer and capacity building.	• Traffic management courses at universities and colleges. • Counterpart and on-the-job training. • Placements and embedding of local staff with international institutions	TACTICAL	SHORT TERM
7. Strengthening local institutions through innovative data collection.	The experience of Freetown, Sierra Leone data collection through anonymized mobile phone data can lead to focused traffic management solutions and lead to institutional development.	OPERATIONAL	SHORT TERM

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4.

TECHNICAL NOTE TWO

GUIDELINES FOR DEVELOPING A FUNCTIONAL ROAD HIERARCHY (FRH)

Photo by Macdavis Johnson on unsplash.com

- *Building on the good practice of Ouagadougou, Burkina Faso.*
- *Managing environmental roads, local roads, secondary roads, and primary roads.*
- *Roadmap to an FRH.*

AVOIDING inappropriate land use by developing a Functional Road Hierarchy (FRH) establishes a foundation for successful traffic management. Naturally, an FRH is useful for prioritizing road infrastructure such as new construction, Public Transport (PT), and road safety. However, an FRH is particularly relevant to traffic management where small scale measures can be rapidly deployed to help improve the predominant functions of each road in a city to the desired effect.

The second theme of this report involves adopting an FRH approach to develop the road network. This report provides a roadmap on how to categorize roads in an FRH, and then move onto developing measures to provide roads that cater to all road users including pedestrians and cyclists, not just motor vehicles. The FRH approach helps to reduce incompatible mixed functions and establishes the predominant function of each road. In this respect, the city of Ouagadougou, Burkina Faso used the FRH concept in its road surfacing program to help prioritize the paving over of dirt roads.

Establishing an FRH can help to AVOID inappropriate land use and achieve safe, efficient road use. An urban FRH is a way of *defining roads by their functions*, not by their physical characteristics or design standards. Most roads perform many functions but they are not often clear cut as roads are not just for moving vehicles. For all road users, a balance needs to be achieved between traffic capacity, environment, speed, safety, convenience, and comfort.

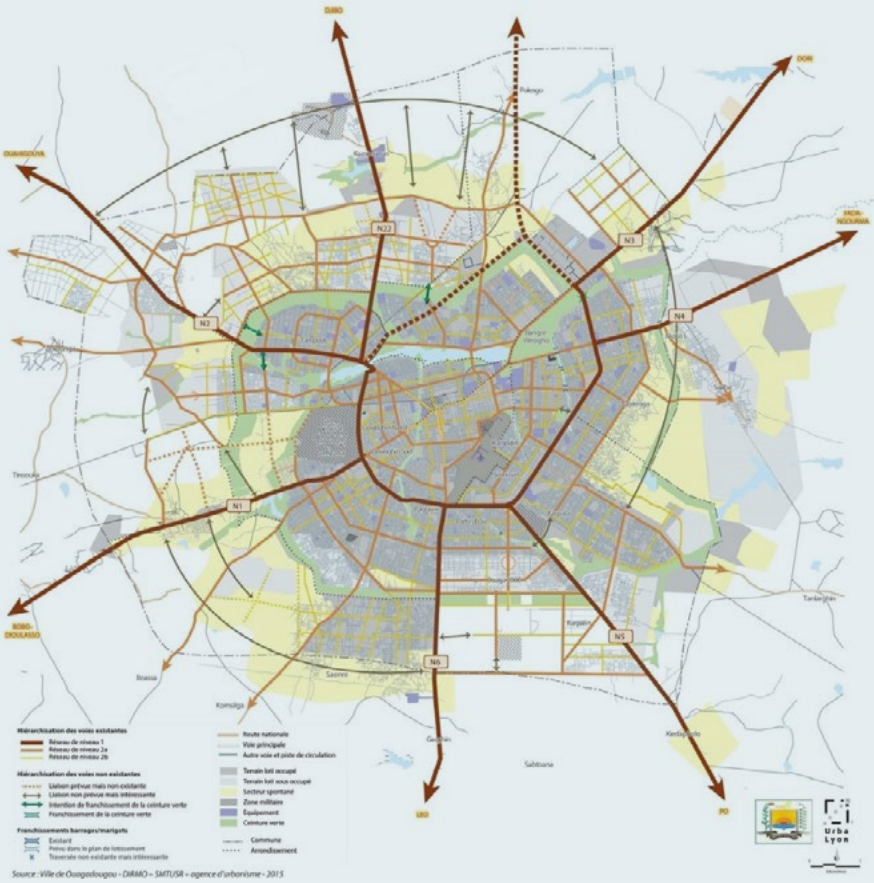
BUILDING ON THE GOOD PRACTICE OF OUAGADOUGOU, BURKINA FASO

The city of Ouagadougou in Burkina Faso adopted an FRH to prioritize the program of road surface upgrading as shown in Box 4.1.

BOX 4.1: FUNCTIONAL ROAD HIERARCHY ENABLES PRIORITIZATION FOR SURFACE UPGRADING IN OUAGADOUGOU, BURKINA FASO

Two objectives of the Ouagadougou Municipal Council's Plan for 2016-2021[72] were to improve urban mobility and enable the integration of transport and land. To facilitate these objectives, the council established the principle of a multi-tiered road network with functional roads at its core, in other words, a Functional Road Hierarchy (FRH). A three-tiered road hierarchy was developed as follows and is shown in the figure below:[73,74]

- **Level 1:** Primary roads (national roads and the ring road) with high Public Transport (PT) and intercity traffic flow capacities
- **Level 2:** Secondary roads with moderate capacity that provide inter-sector access
- **Level 3:** Local roads with neighborhood access functions.



The initial aim was to prioritize investments in surface upgrading. As noted by the World Bank,[75] the city has 2,422k m of roads of which only 22 percent are paved, the remainder being poorly maintained dirt roads.

Another aim is to strike a balance between long distance, circulatory and short distance functions as well as enable the use of roads for other functions such as Non-Motorized Transport (NMT) including

72. Conseil municipal de la commune de Ouagadougou. Programme du conseil municipal au cours du mandat 2016-2021: fiche-actions Projet mobilité.

73. Commune de Ouagadougou, Urbalyon. (2017). Référentiel: Hiérarchie des voiries ouagalaises (Hierarchy of Ouagadougou roads).

74. The World Bank, SSATP Diagnostic Study, Policies for Sustainable Accessibility and Mobility in the Cities of Burkina Faso, October 2019.

75. The World Bank Ouagadougou Urban Transport Project (P168963), Project Information Document/ Integrated Safeguards Data Sheet (PID/ISDS), Concept Stage | Date Prepared/Updated: 15-Jan-2020 | Report No: PIDISDSC25573

Moreover, Box 4.2 shows how Ouagadougou deployed simple traffic management measures to reinforce road functions by physically segregating two-wheeled and four-wheeled vehicles.

BOX 4.2: PHYSICAL SEGREGATION FOR TWO-WHEELED VEHICLES CAN BE LOW-COST IN OUAGADOUGOU, BURKINA FASO

In Ouagadougou, motorcycles comprise 80 per cent of motorized trips due to the lack of Public Transport, both formal and informal. Only 71km of the 2,422km road network[76] have physically segregated lanes dedicated to motorcycles. Mixed traffic has contributed to road crashes with two-wheeled vehicle riders being the most vulnerable.[77]

However, physical segregation to improve road safety can be implemented by low-cost engineering measures such as pre-cast curbs that are shaped to allow vehicles to mount and access the footway curb for loading, and feature gaps to allow emergency escape for motorcycles.[78] They are effective in "naturally" enforcing segregation solely by their good design, precluding the need for further enforcement by the traffic police.

MANAGING ENVIRONMENTAL ROADS, LOCAL ROADS, SECONDARY ROADS, AND PRIMARY ROADS

Figure 4.1 shows international examples of an FRH illustrating how different categories of road form a hierarchy whereby each type of road connects only to the corresponding road category above or below the FRH. For example, a secondary road should ideally connect only up to a primary road or down to a local road in the hierarchy. Ideally, an environmental road should connect only up to a local road and not directly to a secondary or primary road. It is this rigorous connection standard that defines an FRH and which provides the foundation for successful traffic management measures.

Ideally, each road should be designed to have a predominant function; the road's cross-section, speed limit, and adjacent land use should enable a "natural" enforcement of the desired function through its good design. This then provides the appropriate "feel" of the road for road users. A primary road should feel like a busier one with fast moving traffic; an environmental road should feel safe for pedestrians to linger and walk. Roads have to perform a mix of often incompatible functions. It is this incompatibility that has a negative impact on safety and efficiency, and it is this mix of functions that hampers the good operation of a road. This can be seen in the urban roads of Sub-Saharan African cities where through traffic clashes with local markets, parking, and pedestrians. The objective in analyzing a road network using an FRH approach is to reduce such dangerous incompatibilities that drive inefficiency.

76. The World Bank Ouagadougou Urban Transport Project (P168963), Project Information Document/ Integrated Safeguards Data Sheet (PID/ISDS), Concept Stage | Date Prepared/Updated: 15-Jan-2020 | Report No: PIDISDSC25573

77. https://health-policy-systems.biomedcentral.com/articles/10.1186/s12961-020-00654-1 accessed 13 February 2021.

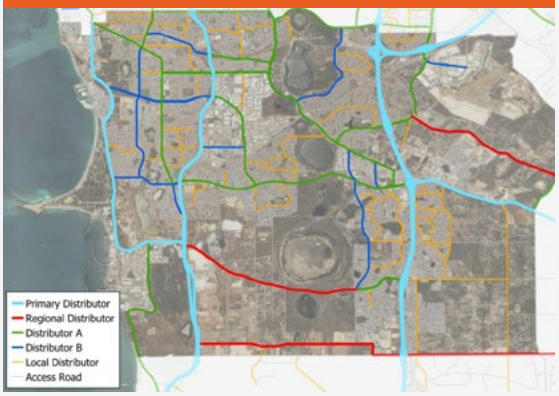
78. https://www.intelligenttransport.com/transport-news/69899/ouagadougou-bus-fleet/ accessed 13 February 2021.

FIGURE 4.1:
International Examples of an FRH[79]

UK, London: City of London

UK, Scotland: Fife Council

Australia: Cockburn



Tunisia: Tunis, Medina

Road functions can be broadly categorized into four types:

- **Type A: Environmental roads with an environmental function** - Used predominantly for pedestrians; predominant functions are walking, sitting out, shopping, living, playing, enjoying nature.
- **Type B: Local roads with local access function** - Used predominantly for Motor Vehicles (MVs) and Non-Motor Vehicles (NMVs); predominant functions are slow moving traffic and traffic-calmed access traffic; access to properties; access for deliveries.
- **Type C: Secondary roads with a distributor/ collector function** - Used predominantly for MVs and Public Transport (PT); predominant functions are traffic distribution, medium distance traffic, PT routes, PT priority.
- **Type D: Primary roads with a through traffic function** - Used predominantly for MVs; predominant functions are fast moving and long-distance traffic, long-distance freight; Integrated Corridor Management (ICM).

79. Source: GoogleMaps adapted by author.

Figure 4.2 illustrates international examples of Type A environmental roads showing how home zones in the Netherlands and traffic cells in Ireland can reduce inappropriate through traffic and enforce this condition naturally through good design features without the need for expensive equipment or monitoring by E-police cameras.

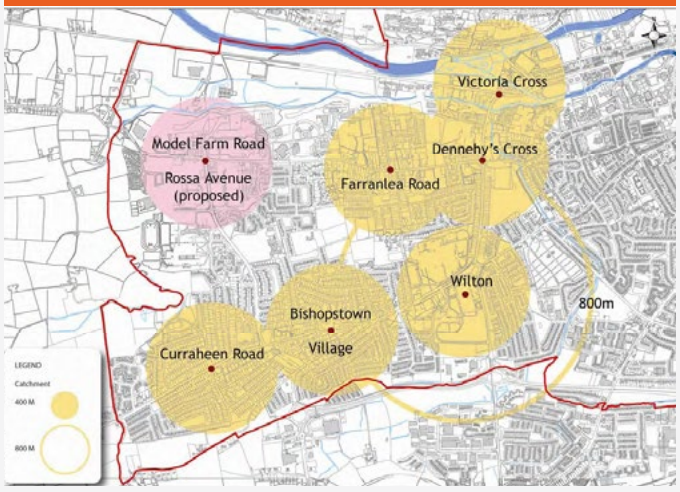
FIGURE 4.2:
Examples of Environmental Roads in an FRH[80]

The Netherlands: Home Zones (Woonerven)

Home Zone (Woonerven) Principles

- Visible entrances to the Woonerven home zone.
- A paved shared space between pedestrians and vehicles.
- Traffic calmed using physical engineering measures.
- Landscaping and street furniture are key.

Ireland, Cork: Traffic Cells



Traffic Cells: Principles

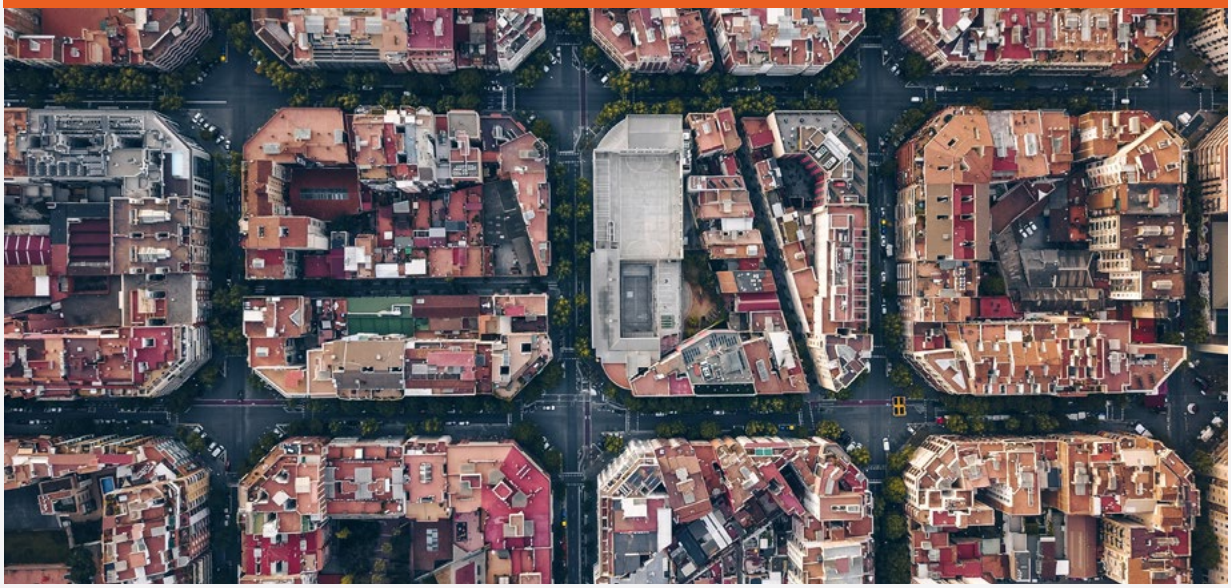
- Residential areas which have direct walking, cycling and PT connections but require a longer trip to travel by MVs.
- MV traffic reroutes around each cell at the edges with no through route through the cell, thus avoiding "rat runs."
- Within the cell priority is given to NMV traffic.

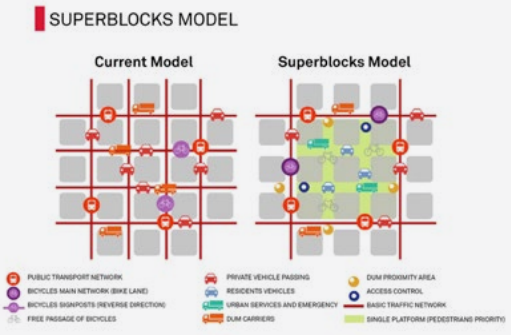
80. Woonerven: http://designbart.blogspot.com/2011/03/woonerf-netherlands.html; Traffic Cells: Cork City Council, Bishopstown and Wilton Area Action Plan, Adopted October 2007, Planning Policy Section, Planning and Development Directorate, Cork, Ireland, 2008.

Figure 4.3 illustrates an international example of Type B local roads showing the superblock layout in Barcelona, Spain, which was reconfigured to prioritize traffic-calmed access for residents, deliveries, and services.

FIGURE 4.3:
Example of Local Roads in an FRH[81]

Spain, Barcelona: Superblocks





- Superblock strategy restricts traffic to several big roads.
- Changes the function of distributor streets into "citizen spaces" for culture, leisure, and the community.
- Makes mini-neighborhoods free of MV traffic as MV traffic flows around them.
- Extensively reduces pollution.

81. http://www.theguardian.com/cities/2016/may/17/superblocks-rescue-barcelona-spain-plan-give-streets-back-residents accessed 8 December 2020; http://www.unsplash.com

Figure 4.4 and Figure 4.5 illustrate international examples of Type C secondary roads which focus on PT routes.

FIGURE 4.4:
Example 1 of Secondary Roads in an FRH[82]

Portugal, Lisbon: Tram Routes

- Radial routes spreading out from the city center to residential areas.
- Can be exclusively for PT or for mixed traffic.
- Road cross-sections can vary in width and whether it caters for on-street parking or not.

FIGURE 4.5:
Example 2 of Secondary Roads in an FRH[83]

Sweden, Stockholm: Secondary Roads as Distributors/Collectors with focus on PT

- Mixed functions with PT as predominant function.
- PT options: central PT corridor or nearside lane PT corridor.
- MVs allowed but pedestrians and cyclists still predominate.
- MV speeds restricted by speed limits, good enforcement, and Road User Education (RUE).

82. Photos by author: Lisbon, Portugal, 2014; Network diagram of Lisbon Transports (Diagrama da rede Transportes de Lisboa), Carris, 2013.

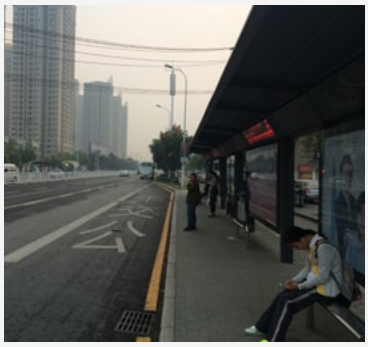
83. Photos by author: Stockholm, Sweden, 2013.

Figure 4.6 and Figure 4.7 illustrate international examples of Type D primary roads.

FIGURE 4.6:

Example 1 of Primary Roads in an FRH[84]

China, Wuhan: Integrated Corridor Management (ICM)



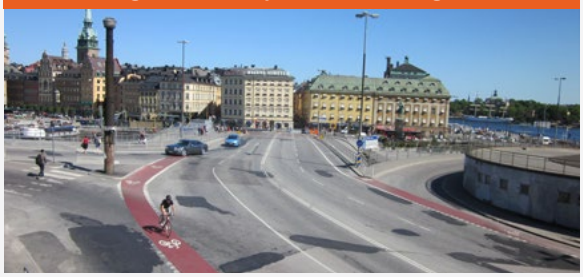
- While the focus is on the main through corridor, adjacent routes and feeder routes must also be considered.
- Whole corridors should be treated at the same time with a package of traffic management measures, essentially the "Three Es": Engineering, Enforcement and Education.

FIGURE 4.7:

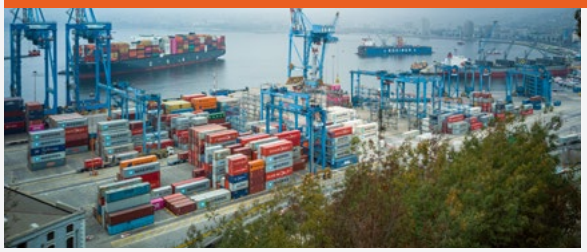
Example 2 of Primary Roads in an FRH[85]

South Korea, Seoul: Through city route with central busway and at-grade pedestrian crossings

Sweden, Stockholm: Nearside bicycle lane on a through route can operate with through traffic



Chile, Valparaiso: Through freight route to/from the port where non-freight vehicles are prohibited to enable freight-only function



84. Photo by author, Wuhan, China, 2014; Fang Ke, Samuel Zimmerman, Wang Wei, Said Dahdah, Gladys Frame (The World Bank, Washington DC 20433, USA), *Integrated Corridor Management for Urban Transport: Concept and Practices*, Urban Transport of China, Vol.10, No.3, May 2012.

85. Photo by author, Seoul, South Korea, 2015; Stockholm, photo by author, Stockholm, Sweden, 2013; Chile, Valparaiso: Photo by David Vives on Unsplash; and https://greenchiletravel.wordpress.com/valparaiso/

ROADMAP TO AN FRH

Tasks for achieving an FRH on an existing road network. An urban FRH on an existing road network can be achieved by:

- Building on the experience of Ouagadougou where the FRH was developed to provide a framework for road surface upgrades.
- Expanding the functions beyond merely being used for surface upgrading to examine road users and adjacent land uses.
- Using the framework of the four types of urban road layout (Types A to D) for guidance.
- Determining the desired predominant function of a road – Should the main function be for through traffic or for local access, or should there be a significant environmental function? While most roads have to perform several functions, the best way forward is to focus on the road's primary function.
- Developing traffic management and/or road construction measures to achieve the desired function.
- Requiring a longer-term solution through road construction if there are gaps in the road network identified through origin/destination surveys and transport modeling.

Dealing with mixed functions. When considering short and medium-term options to adopt an FRH approach, TM measures are key. These types of "bottom-up" measures complement any "top-down" institutional initiatives which may be required. Such TM measures can be designed and implemented within a short timeframe. For example, many urban roads in Sub-Saharan African cities combine market trading areas (with its mix of challenges for pedestrians, traders, small cargo vehicles, and parking spaces) with through traffic. One way to resolve mixed function situations is to decide what the predominant function of the road should be and then manage through an FRH approach.

Predominant through route function. Should the road be part of a key through route that supersedes a market function and should this road have that dominant role? If a through route function is to prevail, then:

- On-street parking should be reduced or eliminated by providing off-street parking elsewhere for the market traders.
- Safety barriers should be built to segregate and protect pedestrians and shoppers/traders at the market from through traffic.
- Protected pedestrian crossings should be installed across the through route including signalized crossing, grade-separated over bridges or underground walkways.
- Current inappropriate land use practices along the through route should be managed to restrict access to individual properties (solutions may include a service road either alongside the main road or behind the properties).
- Provisions should be made for small cargo vehicles that deliver and collect goods in the marketplace.

Predominant market function. If the market function is the most important aspect of a road, then different measures should be considered for implementation including the following:

- Restriction of speeds on the main road.
- Narrowing of traffic lanes to naturally enforce a lower speed limit.
- Providing at-grade signalized crossings for pedestrians.
- Widening of footway to give more space to the market.
- Providing bollards to prevent motor vehicles accessing the market.
- Allowing some on-street parking and servicing as road space is reallocated from moving through traffic to market traffic.

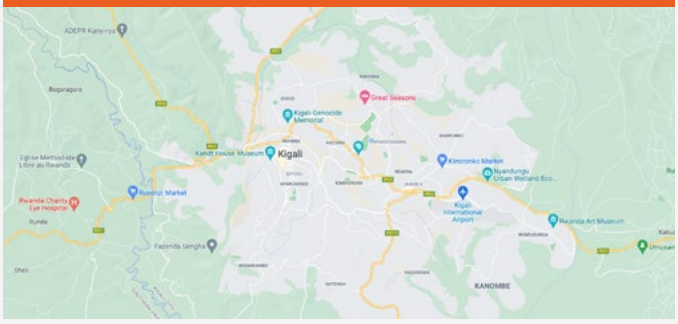

LOTTERIA
Photo by Jana Sabeth on unsplash.com

Figure 4.8, Figure 4.9, and Figure 4.10 illustrate the problems facing the capital cities of Kigali (Rwanda), Addis Ababa (Ethiopia), and the secondary city of Kumasi (Ghana) with respect to achieving an FRH.

The main issue in Sub-Saharan African cities is often the lack of intermediate roads – secondary roads with a distributor/collector function and a focus on PT, and local access roads.

FIGURE 4.8:
Snapshot of Kigali's Road Network in Rwanda[86]

Rwanda: Snapshot of Kigali Road Network

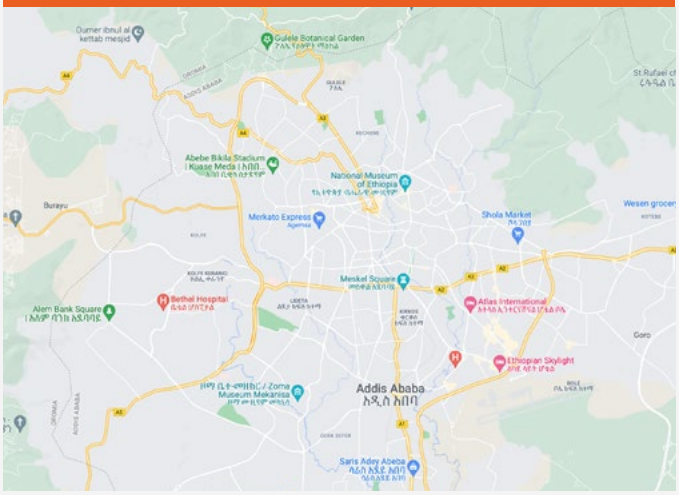


Kigali Road Network Issues

- Undulating terrain restricts east/west connections.
- Lack of primary and secondary roads.
- Local roads connect directly to Primary Road RN3 (National Road).
- Most roads are unpaved; only 16 percent of 2,800km roads are paved.

FIGURE 4.9:
Snapshot of Addis Ababa's Road Network in Ethiopia[87]

Ethiopia: Snapshot of Addis Ababa Road Network



Addis Ababa Road Network Issues

- Window of opportunity to develop mass transit could be missed.
- Lack of secondary roads to connect areas severed by primary roads.
- "Predict and provide" mentality of officials could lead to more primary road construction at the expense of other roads.
- Areas with a lack of road network where the population has limited access to roads.
- "Hot cross bun" layout in the Central Business District (CBD).

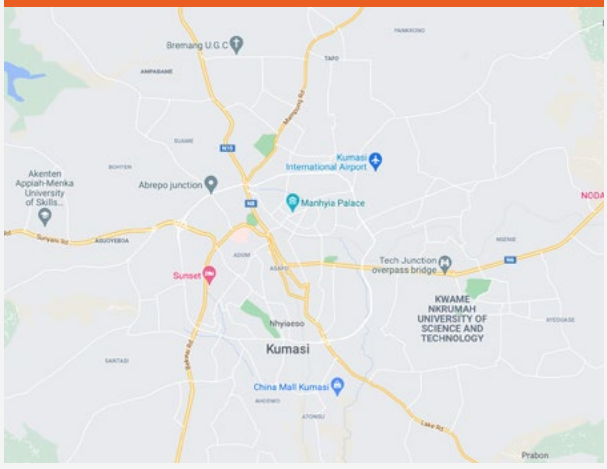
86. GoogleMaps accessed 20 December 2021.

87. GoogleMaps accessed 20 December 2021.

Photo by Reuben Hayfron on unsplash.com

FIGURE 4.10:
Snapshot of Kumasi's Road Network in Ghana[88]

Ghana: Snapshot of Kumasi Road Network



Kumasi Road Network Issues

- Traffic is concentrated on a few primary roads (arterial roads) causing congestion.
- Lack of secondary roads – many local roads connect directly to primary roads thus reinforcing the incompatibility of functions.
- Secondary roads are the key roads for PT which is the main mode of transport in Kumasi; PT operations and scope are severely restricted.
- Primary roads cut through the city center, causing severances for residents.
- Despite NMT being the largest transport mode, the functions of the road network do not cater for NMT in a safe or efficient manner.

88. GoogleMaps accessed 20 December 2021.

Based on the EASI framework, Table 4.1 shows a roadmap and timeframe of strategic, tactical, and operational activities for achieving an FRH.

Table 4.1:
A roadmap of Strategic, Operational and Tactical Tasks for Achieving an FRH

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
AVOID	**Establish an FRH to AVOID inappropriate land use and achieve efficient road use.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• The road categorization systems in many cities in developed countries are based on road functions rather than physical characteristics or design standards; thus, it is useful to study models from the UK, the Netherlands, Europe, North Africa, and other countries. • Build on Ouagadougou's road hierarchy (for road pavement upgrading from dirt roads to paved roads) and explore the potential for expanding the functional definition to apply to road users and land use. • Identify which models of good international practice have the potential to be adopted for Sub-Saharan African cities; this could be different models for different cities.	STRATEGIC	MEDIUM TERM
2. Initiate a program to reform road categorization based on functions.	• Using existing road categorizations as a starting point, examine the functions of key individual roads to determine how well road functions are taken account of. • Draw up a program to refine road categories and base them on road functions for the cities studied, together with the potential to replicate the model nation-wide.	STRATEGIC	MEDIUM TERM
3. Establish an FRH within a regulatory framework.	• Redefine the road classification within a regulatory framework.	TACTICAL	MEDIUM TERM
4. Implement TM measures in a pilot area to reinforce the predominant function(s) of selected roads.	• Carry out a pilot classification/ categorization in a trial area. • Implement road surface upgrade measures and TM interventions to reinforce the desired predominant function of the selected roads; ideally each road should be designed to have a main or predominant function; the road's cross-section, speed limit, and adjacent land use should enable a "natural" enforcement of the desired function by good design. • Evaluate the results. • Replicate throughout the city where appropriate.	OPERATIONAL	SHORT TERM

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5.

TECHNICAL NOTE THREE

GUIDELINES FOR DEVELOPING PEDESTRIAN AND OTHER NMT MEASURES

- *Building on the Sub-Saharan good practice.*
- *Walking plans. The "Three Es." Traffic calming.*
- *Roadmap to better facilities for pedestrians and NMT through junction channelization, little pockets for pedestrians, zebras and road tables.*

SHIFTING the focus of Sub-Saharan African cities to pedestrians and other NMT offers a people-centric approach to traffic management. Pedestrians and other modes of NMT are not well served in Sub-Saharan African cities despite a high percentage of trips being on foot. Streetscapes favor motor vehicles to the detriment of safety and convenience for pedestrians.

The third theme in this report is that small measures lend themselves naturally to pedestrian-friendly facilities such as junction channelization, implementing "little pockets" in streetscapes for pedestrians, and installing zebra crossings and road tables. To enable a modal shift, these measures should be developed within the context of a "safe system"[89,90] approach to road safety as traffic management and road safety are inextricably interlinked. The safe system approach requires a shift in responsibility from those using roads to those designing them. This approach is based on the principle that errors are inevitable, but traffic fatalities and serious injuries should not be. The road system should be designed so that human error does not have a serious or fatal outcome.

Furthermore, parking management (see Chapter 6) is also at the core of improving mobility for pedestrians due to the unregulated practice of parking on footways which forces pedestrians to walk on the roadway. As can be seen in Chapter 6, the development and implementation of an efficient parking management system whereby on-street and off-street parking is regulated and controlled will go a long way to ensuring pedestrian safety.

BUILDING ON THE SUB-SAHARAN GOOD PRACTICE

Car-free days are a start. The city of Kigali, Rwanda has established pedestrian-friendly measures through pedestrianization and car-free days, the latter approach having been replicated in other Sub-Saharan African cities as illustrated in Box 5.1.

Addis Ababa's NMT strategy is a critical foundation for kickstarting pedestrian measures. The urban area of greater Addis Ababa has experienced rapid population growth in recent years with its population approaching five million inhabitants. Despite the recent implementation of a 31km Light Rail Transit (LRT) system and proposals for Bus Rapid Transit (BRT), transport infrastructure has been focused on providing for the private motor car to the detriment of pedestrians. To redress this imbalance, the Addis Ababa Road and Transport Bureau (AARTB) with the support of ITDP developed the ten-year "Non-Motorized Transport (NMT) Strategy" in 2019. The strategy shows a commitment to improving facilities for pedestrians by upgrading 28km of footways and other measures. Over the next eight years (until 2029), the NMT strategy envisions that 600km of footways and 200km of bicycle-ways will be constructed, a public bicycle sharing scheme will commence, and traffic-calmed pedestrian crossings will be implemented. Box 5.2 illustrates the inaugural project on the Lebu-Jemo Corridor.

89. World Resources Institute (WRI), GRSF (Global Road Safety Fund), Embarq, World Bank, *Sustainable and Safe: A Vision and Guidance for Zero Road Deaths*, 2018.

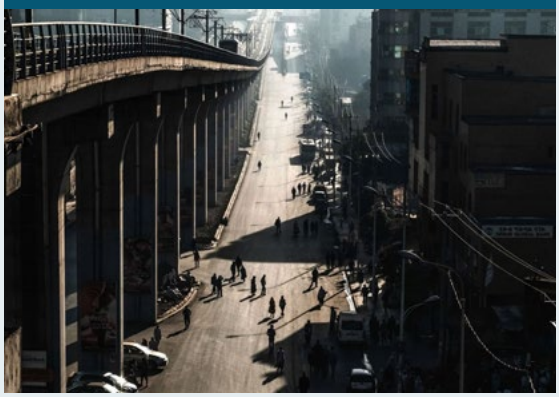
90. World Resources Institute (WRI), GRSF (Global Road Safety Fund), Embarq, World Bank, *Sustainable and Safe: A Vision and Guidance for Zero Road Deaths*, 2018.

BOX 5.1: PEDESTRIAN-FRIENDLY MEASURES IN KIGALI, RWANDA REPLICATED IN OTHER SUB-SAHARAN AFRICAN CITIES

Kigali, Rwanda: Car free street

Kigali, Rwanda: Car free street

Addis Ababa, Ethiopia: Car-free day, February 2019



Kampala, Uganda: Car-free day, February 2019

The city of Kigali pioneered pedestrian-friendly measures to give pedestrians and other NMT the same status as motor vehicles. In 2016, the city started to implement a car-free zone policy with cars banned from one street in the Central Business District (CBD) to expand pedestrianization to other streets in the city center.[91] Also in 2016, Kigali started a monthly car-free day which was soon upgraded in 2017 to twice monthly after President Paul Kagame attended one event. On these days, the function of streets changes from providing for motor vehicles to providing for pedestrians from all walks of life. Residents see this initiative as a starting point in tackling pollution from motor vehicles.[92] Furthermore, Kampala in Uganda[93] and Addis Ababa in Ethiopia[94] have adopted this initiative.

91. SSATP Africa Transport Policy Program/Transitec, Final Report: Sustainable Mobility and Accessibility Policy in Cities of Rwanda, October 2018.

92. https://www.unep.org/news-and-stories/story/car-free-days-are-taking-hold-african-cities accessed 20 February 2021.

93. https://movemobility.nl/car-free-day-in-kampala/#:~:text=February%204%2C%202019&text=On%20the%2027th%20of%20January,from%20all%20walks%20of%20life accessed 20 February 2021.

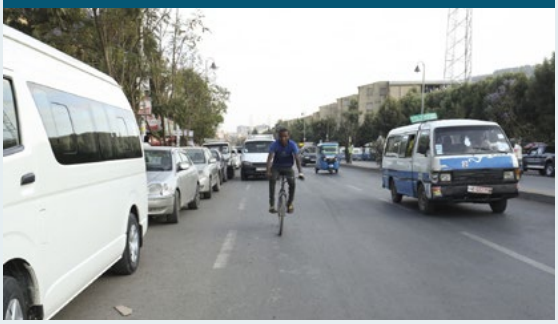
94. https://www.bbc.co.uk/news/world-africa-47107327 accessed 20 February 2021.

BOX 5.2: LEBU-JEMO CYCLING CORRIDOR IN ADDIS ABABA, ETHIOPIA

Under a Non-Motorized Transport (NMT) strategy and a safe cycling program, Addis Ababa, Ethiopia has committed to building 100 km of cycle lanes over the next three years. The three km long Lebu-Jemo Cycle Corridor was the first to be implemented as a demonstration project to kickstart investments in safer and more sustainable transportation in Addis Ababa. The development and implementation of the design required the coordination of agencies responsible for network planning, cycle ownership and regulations, parking, traffic management, kerb-side management, citizen education and enforcement.

The Traffic Management Agency (TMA) and the Addis Ababa Road and Transport Bureau (AARTB) led the transformation as their engineers and ground staff worked for four days and nights to complete the project. Thermoplastic lane markings along the entire length of the corridor were adorned with green markings at all intersections, and curb-cuts were added to indicate the presence of conflict zones. Ground level and curb-side signs were painted and installed to inform the citizens about the new infrastructure on their street. Implementation took 96 hours (in addition to design time), involved 100 people, required 1,400 plastic bollard delineators to segregate the bicycle lane from the vehicle lane, and reallocated over 10,000m^2 of road space to bicycles.

Lebu-Jemo Corridor: BEFORE



Lebu-Jemo Corridor: AFTER

BOX 5.3: THE LONDON WALKING PLAN[96]

Firstly, London's Walking Plan defined the term "walkability" as "... the extent to which walking is readily available to the consumer as a safe, connected, accessible and pleasant activity."[97] Five key aspects were identified as indicators for the Walking Plan, the so-called Five "Cs": Connected, Convivial, Conspicuous, Comfortable and Convenient. The plan involved gathering data and information, analysis of the current situation and identifying different types of walking journeys for school/educational institutions, work, trade, leisure, and shopping.

The barriers to walking were identified as institutional issues, heavy traffic volumes, poor air quality, poor walking environment, lack of safety and security, and access to places by foot.

London also studied the Barcelona case (see Figure 4.3) and carried out case studies in local areas.

Secondly, an action plan with objectives and targets was developed and this led directly to the design of measures which were implemented, monitored and evaluated. These actions were at the heart of the Walking Plan.

WALKING PLANS

Cities which have successfully provided sidewalks for pedestrians have been proactive in developing and implementing walking plans. For example, London initiated its walking plan[95] in 2004 which provided a vision for walking in the capital city of the UK as outlined in Box 5.3. Another example of a walking plan comes from Guangzhou, China, the "NMT and the Five Directions" plan[98] as described in Box 5.4.

Kenya's Street Design Manual for Urban Areas[100] showcases a people-centric focus in a "Complete Streets" approach. This manual was published in 2019 through a collaboration between the Kenyan Ministry of Transport, Infrastructure, Housing, Urban Development, and Public Works (MOTIHUD) in partnership with the Global Road Safety Fund (GRSF) and the Institute for Transportation and Development Policy (ITDP). This manual aims to address the issues of traffic congestion, pollution and deteriorating urban environments in Kenyan cities. The manual also showcases good practice in urban transport design, using a people-centric approach which focuses on pedestrians and cyclists. The manual also utilizes a "Complete Streets" approach which considers the needs of all road users particularly pedestrians, cyclists, and PT passengers. The "Complete Streets" approach recognizes that everyone is a pedestrian at some point in their trip and that more consideration is necessary to provide safe and efficient facilities for walking. This approach is based on prioritizing road safety and balancing the needs of mobility and access with social inclusion and vibrant economic activity together with the need to accommodate critical utilities and allow for efficient maintenance and operations.

BOX 5.4: GUANGZHOU: NMT AND THE "FIVE DIRECTIONS"

Guangzhou's urban transport development strategy for NMT encompassed "Five Directions" for NMT (for pedestrians and cyclists) with the objective of achieving an effective transport system that embodied the key concept principles of "Sharing, Smooth, Intense, Green, and Harmonious."

- **Sharing:** Deploying a multi-modal approach whereby NMT is integrated with other transport modes, especially PT.
- **Smooth:** Using a comprehensive approach that considered NMT as an integral part of road network planning and design.
- **Intense:** Utilizing ongoing innovations in urban design to enhance the provision of pedestrian and NMV facilities.
- **Green:** Promoting walking and cycling as environmentally friendly and sustainable modes of transport.
- **Harmonious:** Highlighting that everyone is a pedestrian at some point in their trip, and thus deploying a "people first" human-centered approach focusing on NMT.

- The NMT strategy from the Guangzhou Strategy Development Study[99] had the following strategic objectives:
- Strengthen the NMT network for NMVs/bicycles and pedestrians according to the "people first" principle.
- In the context of the road network, classify and manage all roads according to their respective functions in an FRH including NMV routes, shared streets, and traffic-calmed zones.
- In the context of PT development, enable a transition from individual transport (including cycling and walking) to public transport.
- Enhance the role of NMVs/bicycles as feeder transport to suburban metro and rail stations and implement bicycle park-and-ride hubs.
- Improve and expand signalized pedestrian crossings, reduce inconvenient and unsafe detours for pedestrians, and implement crossings every 200m on streets for better traffic management.

95. Transport for London, *Making London a Walkable city: The Walking Plan for London*, February 2004.

96. Transport for London, improving walkability: *Good practice guidance on improving pedestrian conditions as part of development opportunities*, September 2005.

97. Ibid.

98. https://www.systramva.com/en-projet/mainland-china accessed 13 January 2021.

99. Ibid.

100. GRSF, ITDP, and the Ministry of Transport, Infrastructure, Housing, Urban Development, and Public Works (MOTIHUD), *Street Design Manual for Urban Areas in Kenya*, 2019.

Quantifying the pedestrian challenge. To tailor solutions that cater to pedestrians and other NMT, it is useful to "quantify the pedestrian challenge." Within the context of an FRH, roads can be analyzed for pedestrian friendliness, and pedestrian behavior can be analyzed in terms of trip origins, destinations and other purposes. Categorizing pedestrian behavior by gender can also be useful; trips by women may be significantly different from those for men, especially in societies where the woman is responsible for the home and grocery shopping. In other societies, women may be the primary traders in markets.

Adopting an FRH (as discussed in Chapter 4) to accommodate NMT functions is illustrated in Table 5.1.

Table 5.1:
Functional Road Hierarchy (FRH) for NMT Functions[101]

CATEGORY	PEDESTRIAN STREETS – RESIDENTIAL	PEDESTRIAN STREETS - SHOPPING	ACCESS ROADS
Predominant Functions	Walking, meeting, eating, sitting outside, playing	Shopping, walking, meeting, eating, trading	Servicing, cycling, walking
Description of Typical Road	Residential lanes and narrow streets in the old city	Shopping streets in the city center	Single section roads
Pedestrian Movement	Predominant; complete freedom	Predominant; complete freedom	Considerable freedom
Bicycle Movement	Local access only	Local access only; push	Considerable freedom; main bicycle route
Cars	No access	No access	Access only
Taxis	No access	No access; only on nearby streets	Access only
Trucks	No access; wider lanes for emergency vehicles	Restricted by permit to deliver; emergency vehicles allowed	Strict control; access for deliveries and emergencies
Public Transport	None but on nearby streets	None but on nearby streets	Possible
Parking Bicycles	Yes	No	No
Parking Cars	No	No	Limited.
Parking Trucks	No	No; controlled loading/unloading only	Limited
Vehicle Access to Individual Properties	None	Controlled for deliveries.	Yes
Local Vehicle Movements	None	None	Some
Through Vehicle Movements	None	None	None
Design Speed	< 10km/h	< 10km/h	30 km/h
Planning Witdh	Up to 10m	Variable.	16 - 24 m
No. of Sections	Single	Single	Single
JUNCTIONS:			
Category Below	Not applicable	Not applicable	At-grade
Same Category	At-grade	At-grade	At-grade
Category Above	At-grade	At-grade	At-grade

101. Source: Adapted by the author from the Guangzhou Urban Transport Study (GUTS1) study in Guangzhou China, 2000.

Table 5.2:
Examples of Pedestrian Levels of Service[102]

Level of Service		Description of movement	Example cities
Peds/min/m	*Peds/h/m*		
19	1,114	Extremely crowded	
18	1,086	Extremely crowded	Wuhan
13	780	Crowding starts	Rome; Hong Kong
11	678	Becoming crowded	
9	525 - 546	Becoming crowded	
7 - 8	432 - 504	Some crowding starts	
8	480	Any kind of walking possible	Singapore; London; Barcelona
2 - 8	148 - 491	Never really crowded	
2 - 3	120 - 180	Never seems crowded	Singapore; London
Under 2	Under 120	Footways seem empty	

Pedestrian density levels are usually achieved naturally as it is difficult to control pedestrian numbers. Several western and Asian cities have aimed to create a more livable city for all road users, including pedestrians. Both Singapore and London have a "human-scale" streetscape with many intermediate and small roads where it is not unpleasant to walk or to sit outside. Like Rome, for example, these cities also have pedestrianized areas. Table 5.2 was developed in the 1990s and is still used as a standard in the 2020s; it aims to quantify pedestrian levels of service whereby pedestrians move along a street.

Carrying out a street audit for NMT. As a starting point for developing pedestrian and other NMT measures, it is useful to carry out a street audit. Some considerations include the following questions to be asked:

- What is the predominant function for the street? Is it a commercial market or a cultural/art area?
- For building heights adjoining the road – is there an appropriate width-to-height ratio for the width of the road to the height of the buildings along the road? This may not seem important to pedestrian conditions but the "feel" of the street and its environment directs and guides the design and conditions of the street.
- Are there curbs or is the surface of the road a single level? Are there road tables?
- Are MVs and NMVs allowed or restricted?
- Are there trees or other flowers and plants to provide shade and greening?

Different kinds of markets. There is a need to recognize the different kinds of commercial and social uses of commercial areas and considerations for different types of shopping such as:

- Wholesale outlets require deliveries from small goods vehicles or trolleys.
- Shopping for daily goods could be more convenient by car or metro so there is a need to consider parking and links to/from metro stations.
- Leisure shopping as a recreational activity and "window shopping" requires a focus more on the shopping environment and making it pleasant to browse along the street – where either a variety of goods or just one type of item are sold.

102. Source: Allan B Jacobs, Great Streets, MIT Press, 1993

Urban Design and "Great Streets." In the 1990s, a debate began in Europe, America, and Australia about why some streets were better than others and why people liked some streets more than others. The ongoing debate intended to examine the characteristics of the better streets and replicate them in cities throughout the world.[103] So, why are some streets "great" while others are not so wonderful? Why are some streets better for different road users - pedestrians, bicyclists, or car or bus passengers?

Different streets have different characteristics. In the UK for example, Edinburgh's "Princes Street" has shops on one side and gardens and the view of Edinburgh Castle on the other. The castle is a focal point of the city and it dominates the urban scene. Streets in Spanish cities such as Barcelona and La Palma (in Majorca) usually have the right balance between street width and building height. Grand boulevards in Paris are "great" in that they are monumental and symbolize the aspirations of the nation. Narrow local lanes in Italian cities such

Photo by Patricia Hokororo on unsplash.com

103. Ibid.

as Bologna, Siena, and Venice, and in the Portuguese cities of Evora and Lisbon can also be "great" in that they have a human scale and natural charm. Streets have been designed for bicycles in Aalborg and Copenhagen in Denmark, and Amsterdam in the Netherlands.

Streets allow people to be outside. In urban areas, especially in densely populated Sub-Saharan African cities, many people do not have access to green areas or pedestrianized plazas within cities, so the street is their "garden" and leisure space. Streets are not just for traffic – moving or stationary – but also for social and commercial encounters. Throughout the world, it is quite common for people to oppose the widening of secondary roads and local roads (to provide for fast-moving through traffic). Instead, they choose pedestrianization schemes to keep their local streets more beautiful and on a more human scale (which provides for people's social needs).

However, it can be difficult for design professionals to physically design a "great street." What should be the function of the street? What width should it be? What should be the height of the adjacent buildings? What facilities and street furniture should be provided? What are the criteria for a "great street?" Some possible criteria for great streets include the following:

- One which has a unique character.
- One which has a role in urban life - a street should help make a community.
- One that is accessible, easy to find and easy to get to.
- One that is comfortable and safe – shady and cool in summer, protected from the rain in winter, sheltered from gusts of wind, and well-lit.
- One that will leave a lasting impression.
- One that will be a model for other streets where the principles and practices can be replicated.
- Streets that are characterized by intangible elements and exude a sort of "magic" - the problem is how to achieve this through the physical design of streetscapes.

Achieving a human scale to the urban streetscape. It is possible with the right mix of land uses, balance of urban features, and physical dimensions to achieve a human scale, even on major roads, larger streets, and boulevards. Key elements of this environment include the following:

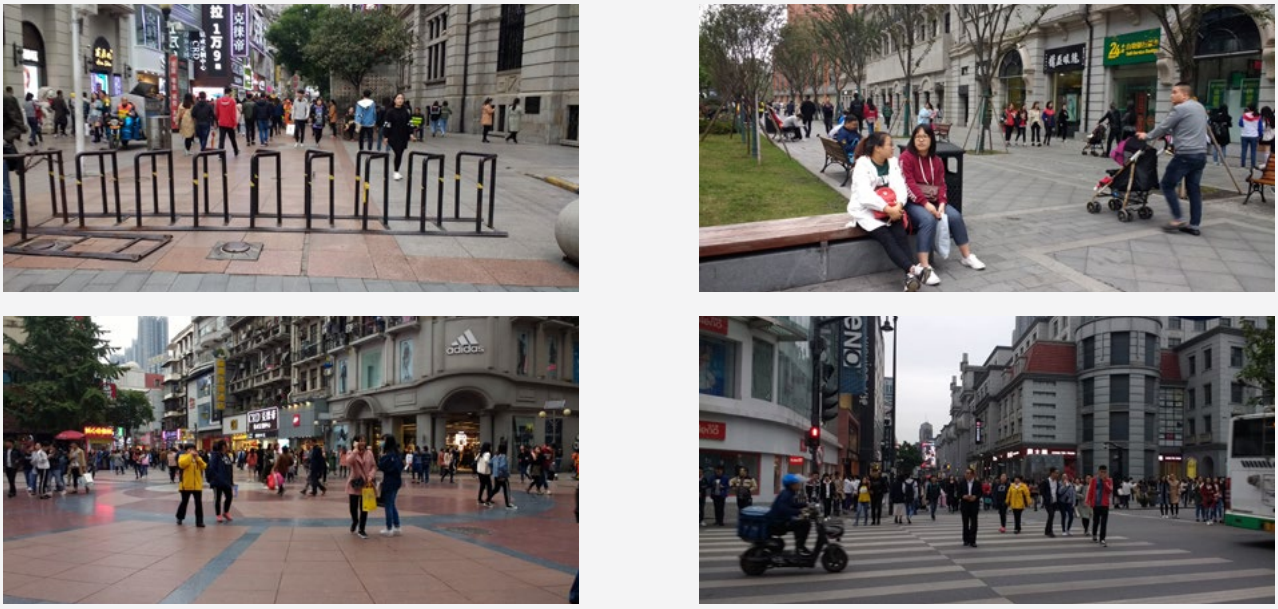
- Continuity of architectural style
- Minimum pedestrian severance (such as wide road, viaduct, barriers, parking, etc.)
- Minimum changes of level
- Safe footway surfacing (not slippery when wet, asphalted surfaces)
- Street furniture/benches (without too much clutter which can obstruct - good design of seats, bollards, barriers, etc.)
- Use of trees and flowers
- Use of water features and urban art
- Abundant lighting
- Protection from weather (heavy rain and strong sun)
- Providing for elderly, disabled, and vulnerable pedestrians including wheelchair users, those pushing strollers and carrying small cargo loads or goods (fewer steps, more ramps).
- Getting rid of MV and NMV parking which encourages unsafe parking maneuvers as vehicles try to get access to stores on footways.

Development of local pedestrian schemes. Pedestrian schemes are best developed locally within the context of a pedestrian/NMT strategy or city-wide walking plan. Such schemes can include the following elements:

- Commerce driven pedestrianization schemes which have become highly successful in China (Figure 5.1) and Europe.
- Working with trading areas on footways to resolve conflicts between pedestrians and MVs.
- Coordinated measures that are integrated and implemented in a single area (such schemes could be comprised of traffic signals, junction channelization, safety barriers, and bollards).
- Integrated corridor approaches (see the example of Wuhan, China in Figure 4.6).
- City-wide application of standard solutions such as footway bollards, junction channelization - see the examples of Kigali (Box 5.5) and Mombasa (Box 5.6).

Managing pedestrians can be achieved by balancing control and accommodating their wishes. There must be a balance between controlling pedestrian traffic and serving their needs. For example, where there is pedestrian severance (by a wide road, viaduct, barriers, parking, etc.), people are much more

FIGURE 5.1:
Pedestrianization Scheme in Wuhan, China[104]



inclined to jaywalk and cross the road at dangerous locations. Often, they have no alternative. Because of the legacy of poor pedestrian accommodations, pedestrian behavior in many Sub-Saharan African cities has devolved to a point of "pedestrian survival" in an aggressive motor vehicle environment. Yet, pedestrians cannot be given complete freedom except in a pedestrianized area, and there is a need to manage large pedestrian volumes at markets, commercial hubs, paratransit hubs, and PT interchanges.

THE "THREE E'S"

Control and management of pedestrians can be achieved by good design and enforcement. Essential to these objectives are the "Three Es" – Engineering, Education and Enforcement:

- **Engineering** - Good physical design which is naturally "self-enforcing."
- **Education** - Road User Education (RUE) to effect a radical change in pedestrian behavior through road safety campaigns with targeted messages.
- **Enforcement** – Either by the traffic police, urban management department staff or civilian traffic wardens.

Two excellent toolkits on traffic management techniques that focused on pedestrians are available online from the Institute of Transport Institute for Transportation Development and Policy (ITDP). These toolkits are in English, Spanish, and Chinese.[105,106] They highlight some key measures as part of a "bottom-up tactical urbanism" approach embodying traffic management techniques.

Accommodating pedestrian traffic - in other words "serving" pedestrians - can be achieved by traffic management initiatives which enhance mobility and accessibility for pedestrians. The focus is on the engineering objective of the "Three Es."

104. Photos by author, Wuhan, China, 2017.

105. https://www.itdp.org/publication/walkability-tool/ accessed 19 February 2021, and available in English, Spanish and Chinese.

106. https://www.itdp.org/publication/footpath-basics/ accessed 19 February 2021.

Engineering solutions include the following:

- **Space for pedestrians.** Creating more space for pedestrians on footways at markets and in commercial and residential areas; reallocating existing road space to pedestrians through pedestrianization and wider footways (see also Functional Road Hierarchy in Chapter 5) such as those implemented in Kigali, Rwanda (see Box 5.5) and Mombasa, Kenya (see Box 5.6).
- **Safe crossing facilities for pedestrians.** Implementing more and better crossing facilities such as at-grade crossings at traffic signals (with central safety refuges on wide roads where traffic management-appropriate) and across major roads where pedestrians utilize "green man" pedestrian traffic signals; installing mid-block signalized pedestrian crossings as shown in Figure 5.2.
- **Access for pedestrians.** Introducing access measures for pedestrians in pedestrian access zones around paratransit hubs and PT interchanges to increase the catchment of paratransit and PT.
- **Commercial hubs.** Accommodate and manage large numbers of pedestrians using physical engineering measures at markets and other major commercial hubs.
- **Traffic calming.** Introduction of traffic calming measures at markets, in commercial areas, near schools and in residential areas:
  - Ensuring footway widths are adequate for the projected volumes of pedestrians and improving footway design, management and maintenance, including by widening footways; getting rid of steps and changes of level; getting rid of obstructions.
  - Rationalizing footway clutter and getting rid of unauthorized vendors at markets.
  - Providing better surfacing that is not slippery or muddy when wet or too dusty when dry.
  - Upgrading street lighting to eliminate "dark pools."
- **Improving pedestrian access.** Minimizing pedestrian severance (defined as the restriction on the possibility - or loss of amenity value - of walking to access nearby locations in order to meet people); changes of surface level through road tables (see Figure 5.9), dropped curbs, and pedestrianization schemes.
- **Ensuring accommodations for vulnerable pedestrians.** Provide accommodations for elderly, disabled and vulnerable pedestrians such as wheelchair users, those pushing baby buggies and those carrying small cargo loads or goods (fewer steps, more ramps).

FIGURE 5.2:
Examples of At-Grade Pedestrian Crossing Layouts[107]

Japan, Tokyo: At-grade pedestrian crossing catering to large volumes of pedestrians

South Korea, Seoul: At-grade pedestrian crossing showing directional crossing practice

107. Photos by author, Tokyo, Seoul, 2015.

BOX 5.5: PEDESTRIAN-FRIENDLY INFRASTRUCTURE IN KIGALI, RWANDA

Kigali, Rwanda: Footway with bollards

Kigali, Rwanda: Footway free of parked vehicles

Kigali has implemented small scale physical improvements which benefit pedestrians to ensure footways are free of parked vehicles and other encroaching activities.[108] These measures are comprised of simple surfacing, curbs, and bollards with excellent success in providing space for pedestrians.

BOX 5.6: WIDE FOOTWAYS IN MOMBASA, KENYA

Mombasa's footway widening program started off as a tourist initiative from the Ministry of Tourism to make the city's streets more attractive for visitors.[109] The program was part of a beautification scheme but clearly has benefits for the resident population. In the first phase, the Department of Transport, Infrastructure and Public Works widened 9km of footways in addition to upgrading street lighting and providing bus bays and traffic signals.[110]

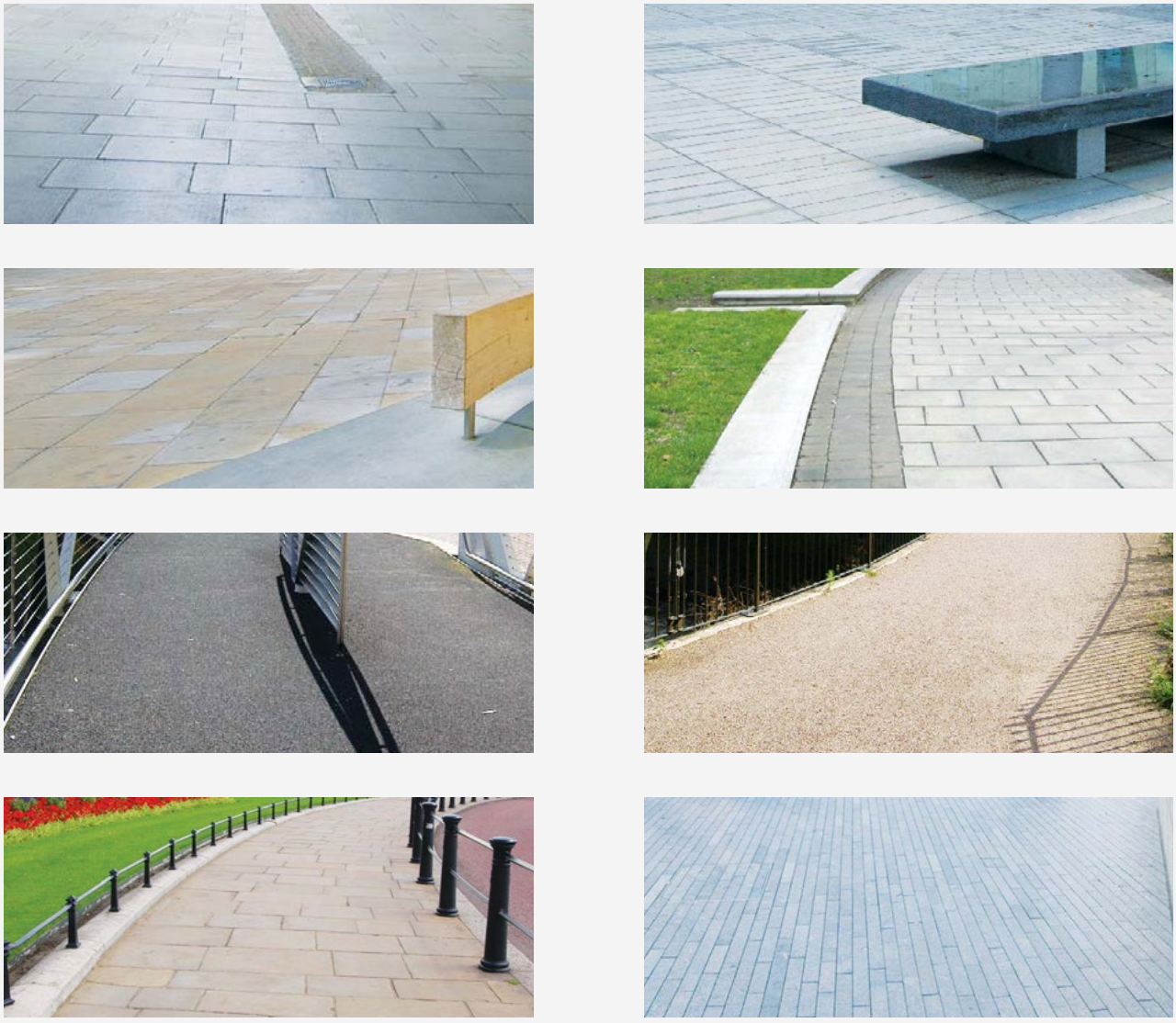
108. https://www.itdp.org/2017/03/06/africa-rising-in-kigali/ accessed 16 February 2021.

109. https://www.itdp.org/2019/03/25/mombasa-sidewalk-expansion/ accessed 19 February 2021.

110. http://www.mombasa.go.ke/transport-and-infrastructure/ accessed 20 February 2021.

Upgrading Surfacing. A key engineering solution is the improvement of the walking surface for pedestrians. This can achieve significant benefits in terms of safety, convenience and efficiency and can kickstart the regeneration of an area and its sidewalks. Upgrading unsurfaced earth roads and market spaces can also transform an area and be a catalyst for other traffic engineering measures. For example, seating, textured surfacing, bollards, and barriers together with signing and road markings, curbs, and dropped curbs (ramps) can be integrated with a resurfacing upgrade. Figure 5.3 illustrates examples of surfacing from London, UK.

FIGURE 5.3:
Examples of Surfacing for Pedestrian Spaces, London, UK[111]

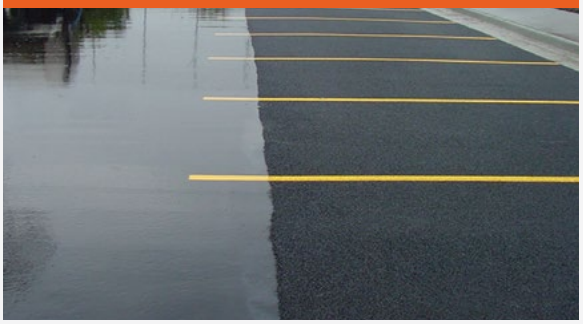


111. *Transport for London, improving walkability: Good practice guidance on improving pedestrian conditions as part of development opportunities*, September 2005.

Sustainable Drainage. Recent advances in permeable asphalt allows water to drain in storm and sudden rain conditions as shown in Figure 5.4.

FIGURE 5.4:
Sustainable Drainage[112]

UK, London: Permeable asphalt



Sweden, Stockholm: Street where road runoff is diverted into a submerged treepit

Innovative surface colors and textures. The Coimbatore Project in India is using "bottom-up" traffic management measures which are low-cost and replicable city-wide. Innovative colored surfacing has been used to demarcate pedestrian areas for crossing roads more safely and for sitting outside as shown in Figure 5.5.[113]

FIGURE 5.5:
Innovative Colored Surfacing in Coimbatore, India[114]

112. Transport for London, *Streetscape Guide*, London,2019

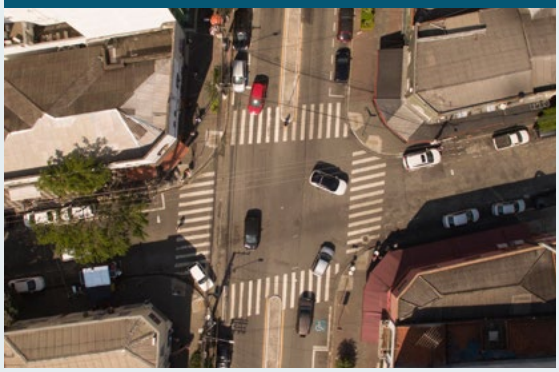
113. *https://www.sutp.org/reclaiming-public-space-in-coimbatore/*

114. Ibid.

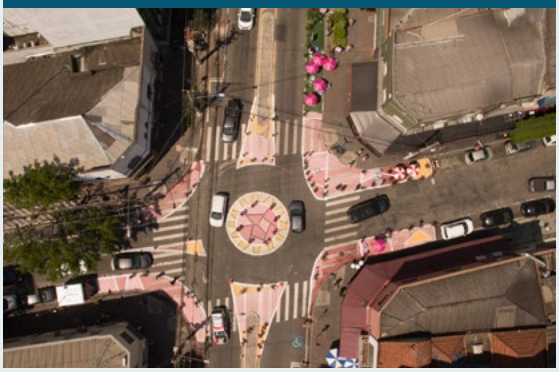
This type of intervention has matured prominently in the "tactical urbanism" of São Paulo, Brazil which is illustrated in Box 5.7. Further information on such "bottom-up" techniques which present a roadmap from pilot schemes to more permanent measures can be found in the tactical urbanism guides.[115,116]

BOX 5.7: SÃO PAULO, BRAZIL: JUNCTION CHANNELIZATION[117]

Santana neighborhood junction: BEFORE

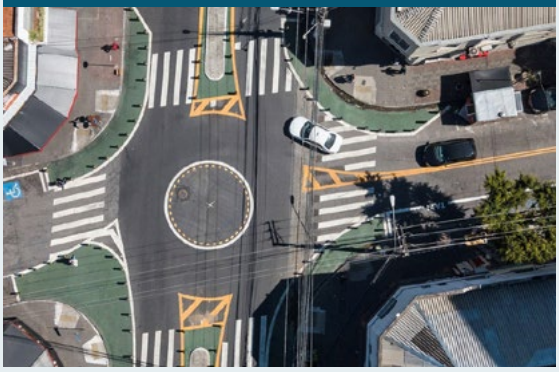


Santana neighborhood junction: AFTER pilot scheme



Santana neighborhood junction plan: BEFORE

Santana neighborhood junction: AFTER permanent scheme



This junction in São Paulo's Santana neighborhood created more space for pedestrians at a vehicle-dominated junction by using colored road markings. These created a roundabout, tightened curb radii and reduced the crossing time for pedestrians. Vehicle speeds were reduced and the commercial area around the junction became a more attractive and safer space for pedestrians.

The colored road markings were a precursor to a more permanent physical design which was then scaled up and replicated in other neighborhoods. The outcomes were that vehicle speeds were reduced by 32 percent and drivers better complied with reduced speed limits.

115. http://tacticalurbanismguide.com/guides/ accessed 19 February 2021.

116. http://tacticalurbanismguide.com/portfolio/asphalt-art-guide-2/ accessed 19 February 2021.

117. https://www.itdp.org/publication/from-pilot-to-permanent/ accessed 19 February 2021.

Education. Targeted road user education campaigns focused on a single message (such as "Don't Jaywalk" and "Wait for the Green Man") or on a key sector of society (such as children or the elderly or young men).

Enforcement. The Enforcement component of the "Three Es" includes the following issue areas:

- Enforcement of MVs and NMVs so that pedestrian space is not occupied by parked or moving vehicles.
- Enforcement of vehicles exceeding the speed limit and becoming a danger to pedestrians (see Figure 5.6).
- Enforcement of rules to reduce dangerous jaywalking.
- Introduction and refinement of legislation for protecting pedestrians.

TRAFFIC CALMING

Traffic calming benefits pedestrians. The term "traffic calming" covers a range of techniques designed to reduce the adverse effect of traffic in urban streets. Traffic calming is a means of controlling vehicle speeds, reducing accident risks, minimizing severance of communities, and improving the environment by using self-enforcing traffic engineering measures such as road humps, chicanes, and carriageway narrowing to discourage non-local traffic.

The good practice of using traffic calming road humps in Tshwane, South Africa is shown in Figure 5.7. These measures have reduced vehicle speeds and ensured greater safety for pedestrians.

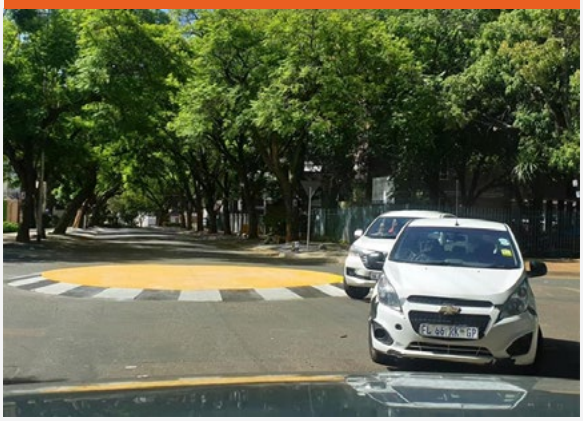
FIGURE 5.6:
Enforcement of Speeding in the UK[118]

118. https://twitter.com/RatSergeant/status/1100085055618199556 accessed 8 December 2020.

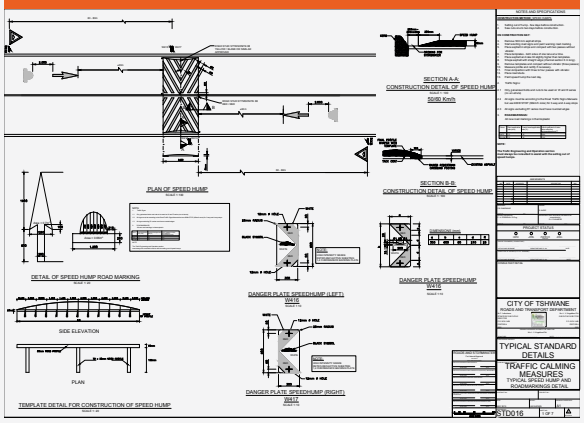
FIGURE 5.7:

Physical Traffic Calming Measures in Tshwane, South Africa[119,120]

Traffic Calming at a Roundabout



Specification for Road Hump



Traffic calming policy of Cape Town. Cape Town's initial traffic calming policy was promulgated in 2008 and revised in 2011.[121] The policy provided for the automatic approval of traffic calming measures (such as road tables, speed humps, raised pedestrian crossings, mini roundabouts) on residential roads in response to public requests, which were subject to conflict resolution practices between different road users. An example is shown in Figure 5.8. It became clear that more public resources needed to be allocated to the road safety strategy for Cape Town to focus on the major road network where most road crashes occurred. The human and financial resources available for Transport for Cape Town (TCT) to respond to traffic calming requests were ultimately inadequate for addressing the number of requests received. As a result, the traffic calming policy was further revised in 2016 to refocus resources towards tackling road safety problems on major roads.

The advent of traffic calming marked a significant change in the approach to traffic engineering in developed countries. The traditional approach was to design road layouts to accommodate increasing volumes of traffic, and this led to an open-road impression which allowed excessive speeding and contributed to the domination of urban roads by motor vehicles in non-congested time periods. Traffic calming has re-examined this approach, resulting in schemes which benefit all road-users including cyclists and pedestrians. These new approaches are being applied in both residential and downtown commercial areas.

There is sufficient scope to introduce traffic calming measures customized for Sub-Saharan African cities. In Europe, there has been growing interest in the use of traffic calming techniques to improve facilities for pedestrians. In Asian cities, this concept is just beginning to be recognized and tentative steps are being made to adopt traffic calming measures such as road humps, pedestrianization and lower speed limits.

119. https://rekordeast.co.za/292324/project-to-fix-tshwane-roads-set-to-continue accessed 16 February 2021.

120. http://www.tshwane.gov.za/sites/residents/Services/Documents/STD016_sh1of7.pdf accessed 16 February 2021.

121. TDA Cape Town (The City of Cape Town's Transport and Urban Development Authority), TRAFFIC CALMING POLICY, Policy No: 45396, Approved by Council 28 May 2008C11/05/08, Further amendment by Council, 22 June 2011 vide c08/06/, updated 2016.

Traffic calming measures include both vertical and horizontal deflection features to reduce MV speeds such as:

- Road humps of many different shapes with different vertical profiles (some more rounded, some flatter).
- Road "cushions" and road "tables" (see Figure 5.9) and thermoplastic road humps.
- Rumble devices that create uncomfortable vibrations for MVs including short lengths of "rumble strips" and longer lengths of "rumblewave" surfacing (see Figure 5.10).
- Bollards to protect the sidewalk from parked vehicles and prevent MVs from mounting the curb by temporarily restricting their movement (see Figure 5.11).
- Chicanes or physical islands which make MVs zigzag and therefore slow down.
- "Gateways" with features that mark the start of a traffic calmed area and let drivers know that they are entering a special zone.
- "Gateways" with road markings (especially "dragon's teeth" road markings, islands, bollards, and even archways).

FIGURE 5.8:
Traffic Calming Road Table at Pedestrian Crossing in Cape Town, South Africa[122]

122. https://www.iol.co.za/capeargus/motoring/city-of-cape-town-says-traffic-calming-devices-are-too-costly-42021222 accessed 9 April 2021.

FIGURE 5.9:
Examples of Road Tables[123]

South Korea, Seoul: Road table combined with a pedestrian crossing

Singapore: Road table

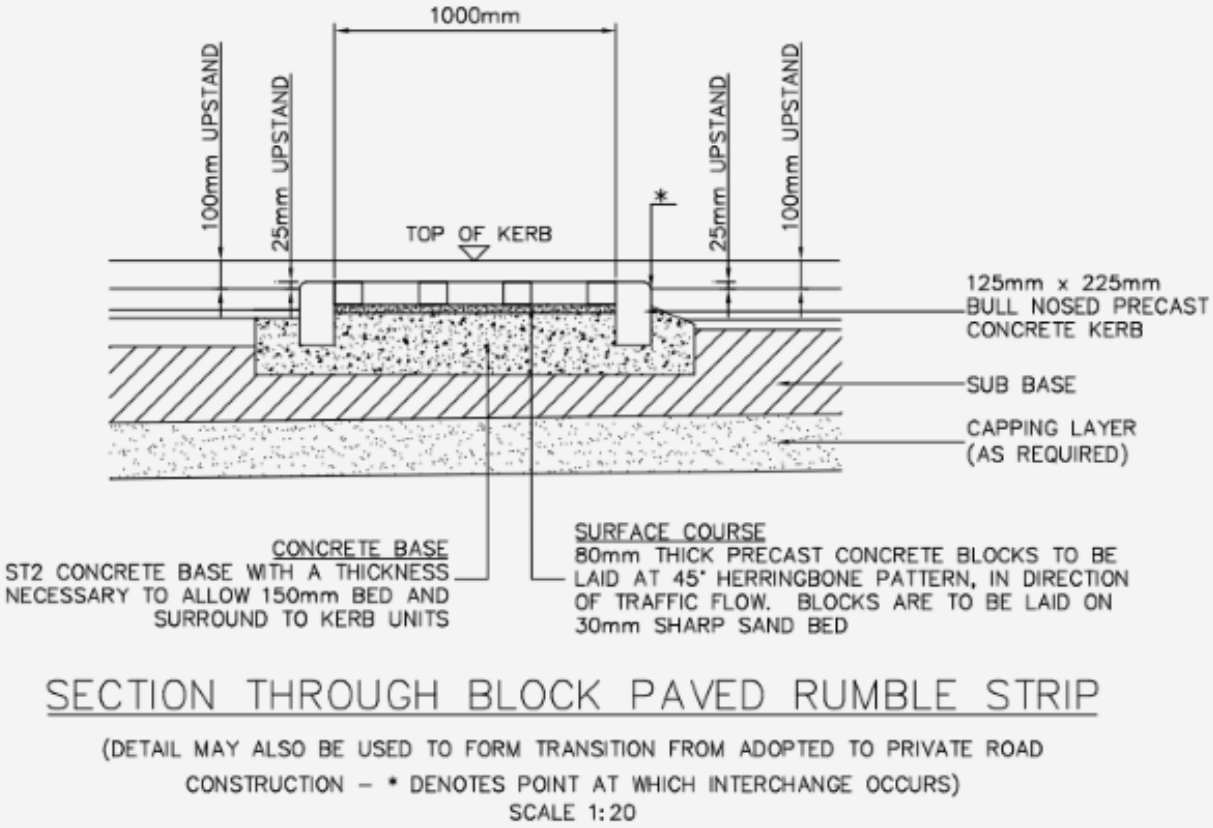
UK, London: Road table on a local road at junction with secondary road enabling no change of level for pedestrians

Netherlands, Amsterdam: Road table in a home zone (Woonerf)

123. Photos by author: Seoul and Singapore, 2015; London, UK, 2018; and Amsterdam, Netherlands 2014.

FIGURE 5.10:

UK: Examples of Rumble Strips/Rumblewaves[124]



124. https://mocktheorytest.com/resources/rumble-strips-explained/; UK Essex County Council, Local Highway Panel, Members' Guide2, Speed and Traffic Management, 2007.

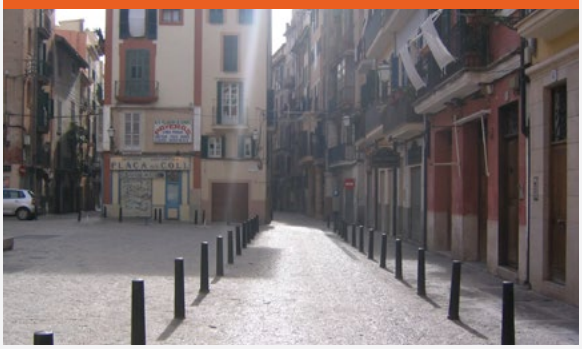
FIGURE 5.11:
Examples of the use of Bollards to Restrict MVs[125]

UK, London: Bollards to prevent vehicles mounting the footway

Netherlands, Amsterdam: Pop-up bollard to temporarily restrict MVs

China, Guangzhou: Bollards and dropped curb

Spain, Palma de Mallorca: Bollards segregate MVs and pedestrians



DETAILED ROADMAPS FOR IMPLEMENTATION OF SMALL MEASURES THAT LEND THEMSELVES NATURALLY TO PEDESTRIAN-FRIENDLY FACILITIES

Table 5.3. Table 5.4 and Table 5.5 present detailed roadmaps for the small measures discussed above: implementing junction channelization; providing little pockets for pedestrians in urban streetscapes; and installing zebra crossings and road tables.

Complementing the detailed roadmaps for the small measures, Table 5.6 presents a broader roadmap and timeframe of strategic, operational, and tactical tasks for enhancing public accommodations for pedestrians.

125. Source: Photos by author: London, UK, 2018; and Amsterdam, Netherlands 2014, Guangzhou 2007; Spain, Palma de Mallorca 2007.

Table 5.3:
Detailed Roadmap for Implementing Junction Channelization

Task	Roadmap	Task Details
1	Task name	Junction channelization
2	Objectives	• To streamline junctions for motor vehicles to improve safety and efficiency. • To bring stop-lines forward to reduce the time that vehicles need to cross the junction.
3	Framework	Functional Road Hierarchy (FRH)
4	Technique 1: Simple	Hatched road markings on the roadway, guidance markings for pedestrians and stop-lines for vehicles; give way signs and markings.
5	Technique 2: Intermediate	Physical junction channelization islands with curbs and bollards
6	Technique 3: Advanced	Enhanced civil works including dropped curbs, textured surfacing, rumble strips to reduce speed, traffic signals, ITS
7	Key design elements and design standard	Technical drawing showing dimensions
8	Examples: developing countries	Latin America, Sub-Saharan Africa
9	Examples: developed countries	Europe, Australia
10	Essential add-ons	Road User Education (RUE); Enforcement
11	Identify a champion of the technique to push forward design and implementation	For example, the city mayor
12	Responsible agency for design	Identify agency
13	Responsible agency for implementation	Identify agency
14	Responsible agency for enforcement	Identify agency
15	Pilot area implementation	Determine the area and the number of junctions - for example, five junctions.
16	M&E of pilot area	• Feedback from road users and agencies • Road crashes reduced through reduced conflicts • Time taken to cross junction reduced
17	Scheme refinement	If necessary, refinement of design elements, implementation procedure, enforcement, and education
18	Roll out city-wide of Simple Technique	For example, ten junctions across the whole city
19	Roll out city-wide of Intermediate Technique	For example, ten junctions across the whole city
20	Roll out city-wide of Advanced Technique	For example, ten junctions across the whole city
21	Final M&E and replication citywide	For example, 50 junctions citywide

Table 5.4:
Detailed Roadmap for Providing "Little Pockets" for Pedestrians

Task	Roadmap	Task Details
1	Task name	Small pedestrianization schemes
2	Objectives	• To utilize spare and otherwise unused pockets of land to provide small pedestrianized areas where vehicles are banned. • To provide a safe space for pedestrians and other vulnerable road users. • To recognize that pedestrians are road users too and that they need to be catered for.
3	Framework	Functional Road Hierarchy (FRH)
4	Technique 1: Simple	Barriers and bollards to prevent vehicles entering the proposed pedestrian space
5	Technique 2: Intermediate	• Asphalt surfacing • Colored and textured surfacing • Road markings • Seating • Greenery such as trees and planters.
6	Technique 3: Advanced	Full pedestrianization of commercial and market areas using with major civil works
7	Key design elements and design standard	Technical drawing showing dimensions
8	Examples: developing countries	Brazil, India
9	Examples: developed countries	Netherlands, UK
10	Essential add-ons	Road User Education (RUE); Enforcement
11	Identify a champion of the technique to push forward design and implementation	For example, the city mayor
12	Responsible agency for design	Identify agency
13	Responsible agency for implementation	Identify agency
14	Responsible agency for enforcement	Identify agency
15	Pilot area implementation	Select one area, either city center or suburban
16	M&E of pilot area	Feedback from pedestrians and agencies
17	Scheme refinement	If necessary, refinement of design elements, implementation procedures, enforcement, and education
18	Roll out city-wide of Simple Technique	Five areas across the whole city
19	Roll out city-wide of Intermediate Technique	Five areas across the whole city
20	Roll out city-wide of Advanced Technique	Five pedestrianization schemes across the whole city
21	Final M&E and replication citywide	Ten pedestrianization schemes citywide

Table 5.5:
Detailed Roadmap for Installing Zebras and Road Tables

Task	Roadmap	Task Details
1	Task name	Crossing facilities for pedestrians
2	Objectives	• To provide at-grade safe road crossing facilities for pedestrians. • To reduce pedestrian casualties from road crashes. • To enable a pedestrian-friendly city that is safe and convenient for pedestrians and other vulnerable road users.
3	Framework	Functional Road Hierarchy (FRH)
4	Technique 1: Simple	Zebra crossing markings and Belisha beacons at selected mid-block sites on selected roads
5	Technique 2: Intermediate	Civil works to add-on physical road tables to give a change of level for vehicles (to slow vehicles down and reduce speeding) but no change of level for pedestrians
6	Technique 3: Advanced	Add-on traffic signals to signalize the mid-block zebra crossings on the road tables
7	Key design elements and design standard	Technical drawing showing dimensions
8	Examples: developing countries	Pictures to be input
9	Examples: developed countries	Pictures to be input
10	Essential add-ons	Road User Education (RUE); Enforcement
11	Identify a champion of the technique to push forward design and implementation	For example, the city mayor
12	Responsible agency for design	Identify agency
13	Responsible agency for implementation	Identify agency
14	Responsible agency for enforcement	Identify agency
15	Pilot area implementation	Determine the area and install five zebras and/or zebras on road tables.
16	M&E of pilot area	• Feedback from road users and agencies • Road crashes reduced through reduced conflict • Pedestrian convenience • Pedestrian routes
17	Scheme refinement	If necessary, refinement of design elements, implementation procedure, enforcement, and education
18	Roll out city-wide of Simple Technique	Ten mid-block sites across the whole city
19	Roll out city-wide of Intermediate Technique	Ten mid-block sites across the whole city
20	Roll out city-wide of Advanced Technique	Ten mid-block sites across the whole city
21	Final M&E and replication citywide	50 mid-block sites citywide

Table 5.6:

A Roadmap of Strategic, Operational and Tactical Tasks for Developing Pedestrian and other NMT Measures

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
SHIFT	**Develop pedestrian and other Non-Motorized Transport (NMT) measures to SHIFT the focus away from motorized modes in a people-centric approach using "Three E" measures, junction channelization, pedestrian pockets and traffic calming.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• Define "walkability" for Sub-Saharan African cities. • Build on good local experience from Kigali, Mombasa, Addis Ababa, and Tshwane. • Gather data and information; analyze situation, identify issues and barriers to walking. • Identify different types of walking, different walk trips for different purposes disaggregated by gender. • Case Studies: São Paulo, London, Barcelona, Guangzhou, Seoul, Singapore.	STRATEGIC	MEDIUM TERM
2. Develop and set out the strategic approach.	• Quantifying the pedestrian challenge. • Functional Road Hierarchy for NMT, • Pedestrian level of service. • Human scale of cities. • "Three Es": Engineering, Enforcement, Education. • Traffic calming.	TACTICAL	MEDIUM TERM
3. Implement "bottom-up" pedestrian schemes.	• Implement measures within the context of local pedestrian schemes. • Monitor and evaluate measures. • Replicate good practice citywide, nationwide and throughout the region.	OPERATIONAL	MEDIUM TERM

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6.

TECHNICAL NOTE FOUR

GUIDELINES FOR DEVELOPING A PARKING MANAGEMENT SYSTEM

- *Building on initial steps of parking reform in Maputo and Addis Ababa*
- *Single parking authority*
- *Hierarchy of parking zones with differentiated pricing*
- *Smart parking. Parking as a business*
- *Roadmap for a "Parking Turnover Makeover"*

SHIFTING the focus of Sub-Saharan African cities away from motorized modes is key to enabling livable and greener cities. Notwithstanding the rapid motorization and increased levels of traffic congestion in African cities, there are still opportunities to shift the focus away from providing for additional motorized modes to policies that address the needs of pedestrians and other NMT. To enable a modal shift, the fourth theme of this report focuses on establishing a parking management system to kickstart a "parking turnover makeover." Both on-street and off-street spaces would be managed more efficiently to limit all-day commuter parking and allow a turnover of vehicles to serve local communities and generate revenue. However, the window of opportunity is rapidly shrinking for Sub-Saharan African cities to deploy new parking management reforms as Transport Demand Management (TDM) measures and develop parking zones with differentiated pricing. These problems need to be addressed before streetscapes become overwhelmed with uncontrolled parked vehicles.

Importance of parking management. Good parking management is also crucial in enabling a safer and more convenient environment for pedestrians. In many Sub-Saharan African cities, parked vehicles are unregulated, uncontrolled, and often occupy sidewalks which forces pedestrians to walk on the roadway. Enabling systematic implementation of on-street and off-street parking in a regulated zonal system that is managed and enforced can play a key role in ensuring better facilities for pedestrians.

Rapidly diminishing window of opportunity for tackling parking problems in African cities. As stated above, there is a small "window of opportunity" to tackle parking problems in Sub-Saharan African countries before streets and adjacent spaces become overwhelmed with parked vehicles resulting in increased congestion, high vehicle emissions, and poor road safety. Most developing cities have other urban transport concerns to address, however, and this is the case in much of urban Africa where this "window" has been lost. Consequently, cities need to play "catch-up" by belatedly strengthening institutions, carrying out parking surveys to obtain data, and quickly developing strategies and implementing measures to address the issue.

Lack of a comprehensive approach. Some Sub-Saharan African cities plan to tackle parking problems but are unsure on how to proceed as their focus tends to be on piecemeal measures rather than a comprehensive plan.[126] In Kigali, Rwanda, there is a proposal to discourage the use of private cars by restricting on-street parking. In Nairobi, Kenya, the city is planning to increase the number of parking spaces by building multi-story parking lots in the CBD. In Addis Ababa, Ethiopia, draft legislation has been submitted to the city council to develop a municipal parking strategy. However, all these proposed measures are merely outlying elements of a generally non-existent parking policy. Cities should first conduct parking surveys to establish a foundation of data to quantify the dynamic of parking supply and demand, thereby providing the rationale for developing the international standard solution of a hierarchy of parking zones with different tiered charges depending on the location.

126. Africa Transport Policy Program (SSATP)/Transitec, Final Reports: *Sustainable Mobility and Accessibility Policy for Kenya's Cities, Urban Areas of Ghana, Urban Areas of Nigeria, Cities of Ethiopia, and Cities of Rwanda*, 2018.

BUILDING ON INITIAL STEPS OF PARKING REFORM IN MAPUTO AND ADDIS ABABA

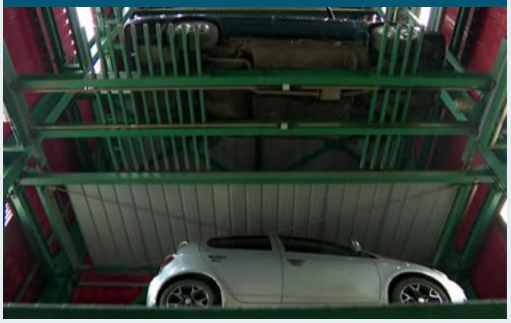
Maputo on-street parking meters. Some cities in Sub-Saharan Africa are playing "catch-up." Under the World Bank-funded Promaputo II project[127] in Maputo, Mozambique, parking meters have been installed in some areas of the Central Business District (CBD) to regulate parking and encourage parking turnover. While the initial aim was to address an alleged shortage of parking spaces, this initiative needs to be part of a zonal parking management system which addresses both on-street and off-street parking using a more integrated approach.

Addis Ababa mechanical parking system. In 2017, the city of Addis Ababa, Ethiopia, installed a mechanical parking system as the city leapfrogged to the latest technology for parking as shown in Box 6.1.

BOX 6.1: ADDIS ABABA MECHANICAL PARKING LOTS[128,129]

The city of Addis Ababa has few off-street car parks with most parking taking place on-street. Motor vehicles circulating the streets looking for a parking place contribute to severe congestion and high vehicle emissions. The Master Plan for the city (2017–2027) aims to tackle these issues by first addressing the parking situation. In 2017, the city installed a mechanical parking system for 140 cars in a custom-built 15 story building; it envisions replicating this model in 60 other locations. The cost was US$1.5 million, financed by the Government of Ethiopia and constructed by the Chinese Dayang Auto-Parking Equipment Company and a local company, Sysproen Systems and Engineering Ltd. The Transport Programs Management Office (TPMO) in Addis Ababa recognizes the challenges involved in balancing parking supply and demand with a more comprehensive parking management system with differentiated pricing by zones. Many citizens are also concerned about the increase in the numbers of high-rise buildings with mechanical parking silos which are irrevocably changing the heritage streetscapes of Addis Ababa.[130]

Megenagna Smart Parking Interior



Megenagna Smart Parking Interior

127. MAPUTO: The World Bank, Promaputo Projects I and II, https://projects.worldbank.org/en/projects-operations/project-detail/P096332?lang=en accessed 10 February 2021.

128. https://www.c40.org/case_studies/addis-ababa-s-megenagna-smart-parking-as-an-instrument-to-reduce-ghg-emissions-improve-air-quality-and-reduce-traffic-jams accessed 16 February 2021.

129. https://africa.cgtn.com/2017/06/10/ethiopia-introduces-first-smart-parking-system-in-africa/ accessed 16 February 2021.

130. https://www.theguardian.com/global-development/2021/feb/10/can-addis-ababa-stop-its-architectural-gems-being-hidden-under-high-rises accessed 10 February 2021.

Parking Management and Traffic Impact Assessment Studies -- A model report on parking management from Addis Ababa. In addition to testing the latest technology of mechanical parking silos, the city of Addis Ababa also recognized the need for a rational parking management strategy. To this end, the World Bank funded a report entitled "Parking Management and Traffic Impact Assessment Studies," which was published in 2018.[131] While the counterpart to the World Bank and its consultants was the Addis Ababa City Roads Authority (AACRA), the direct client was the Addis Ababa City Administration Road Traffic Management Agency (TMA). The objective of the report was to develop an implementation parking strategy and a traffic impact assessment program which would meet the future transport and parking challenges of the city.

Problems documented. The parking management and traffic impact assessment documented a lack of policy guidelines, paid parking, and parking enforcement in Addis Ababa. All these elements led to "chaotic parking conditions and disruptions in the flow of traffic."[132] While there were numerous off-street paid parking lots available, on-street paid parking was non-existent. This situation was detrimental to efficient traffic flow and the interests of pedestrians. When enforcement was carried out by traffic police, it was inefficiently performed.

Model for simple data collection. The parking management report is a model for other Sub-Saharan African cities to emulate. The consultants not only involved academia through students from Addis Ababa University but also conferred significantly with local citizens. The work was linked to other transport projects in the city and was not carried out in isolation. The report makes the critical point that parking management is part of the urban transport landscape and needs to be considered in conjunction with other transport initiatives. Crucial data were obtained by surveying sidewalks and the condition of the road and sidewalk surface, thus ensuring that there was substantial evidence to show how pedestrians were impacted by unregulated and uncontrolled sidewalk parking. Originally, it was envisioned that parking turnover and duration surveys would be carried out using GIS databases, tablet computers and city Wi-Fi. However, these technologies failed to live up to expectations. As a result, the survey work was carried out manually by surveyors walking the street network to record parking turnover and duration with clipboards and pencils. These manual methods in no way compromised or reduced the data. Indeed, they provide a model for other Sub-Saharan cities to follow if certain technology is not available.

Institutions for parking are undeveloped. For many Sub-Saharan African cities, the responsibility for parking strategy (encompassing policy, planning, and funding) is typically split between different government agencies and often at an administrative level higher than the city or municipal level where this task would be ideally suited. At a tactical level (encompassing regulation, contracting, pricing, infrastructure, and equipment) and at an operational level (encompassing operations, maintenance, enforcement), the situation is worse with many cities yet to determine which agency should be responsible for these tasks. Such responsibilities are still un-defined and there are latent conflicts between agencies and stakeholders. For further information, see Table 6.1 which presents the "Governance Matrix for Parking Management in Selected Sub-Saharan African Cities." in Selected Sub-Saharan African Cities. Some parking is controlled by a city government and some is privately controlled; much of it is uncontrolled, however. Some parking spots charge a fee while others are free, and can be on-street or off-street.

The price of not addressing free or underpriced parking. There are many detrimental effects of heavily subsidized free or low-cost parking. This practice favors private motor vehicles and skews travel choices away from PT, paratransit, and NMT. Furthermore, drivers circulating the area looking for a free parking space contribute to increased vehicle travel, congestion, emissions, and ultimately more accidents.[133] The parking system has to be changed or it will become even more of a problem in Sub-Saharan African cities due to rapid motorization and centralized urbanization. These cities are on the brink of experiencing a parking "time bomb" given the growing "sea of cars" along streets aand round most office and commercial buildings.

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131. Addis Ababa City Roads Authority (AACRA). Parking Management and Traffic Impact Assessment Studies for Addis Ababa, Draft Inception Report. August 2018.

132. Ibid.

133. Shoup, Donald, The High Cost of Free Parking, accessed 3 December 2020, https://www.researchgate.net/publication/235359727_The_High_Cost_of_Free_Parking

Table 6.1:
Governance Matrix for Parking Management in Selected Sub-Saharan African Cities[134]

Level	Sector	Ethiopia		Kenya	Nigeria		Ghana	Rwanda
		Addis Ababa	Secondary Cities	All Cities	Lagos State	Abuja	Accra	Kigali
STRATEGIC: ***What strategies with what resources?***	Policy and planning (federal)	TA/TPMO	MoT	Counties are responsible; but the responsibilities are not defined and there are latent conflicts between agencies and stakeholders	FMoW/FMoT *not defined;* LASMoT	FMoW/ FMoT *but not defined;* FCTA	MMDAs *but not defined;*	City of Kigali
	Policy and planning (regional)		Region & municipality TD					
	Funding	Municipal budget and loans	Municipal budget and loans		LASMoT	FCTA/Private	MMDAs	
TACTICAL: ***What services should be developed and how to go about it?***	Regulation	MoT	MoT		LASTMA	FCTA *but not defined*	MMDAs	
	Licensing, permits and contracting	TA	*None*		LAMATA	FCTA	MMDAs	
	Fares and pricing	TA	*None*		LASMoT	FCTA	MMDAs	
	Infrastructure and equipment	TA	Region & municipality TD		FMoW/ LASMoWI	FCTA	MMDAs	
OPERATIONAL: ***How to enable efficient services?***	Operations, maintenance and enforcement	To be determined	To be determined		Local government transport planning units *but not defined*	AUMTCO (a public company)	MMDAs	Associations

Parking management as a Transport Demand Management (TDM) measure. Cities can use a TDM measure to SHIFT the focus of parking location and price management away from private motorized transport modes by making parking more expensive in city center locations. The goal is also to SHIFT all-day commuter parking to a more dynamic parking turnover rate to stimulate the economic vibrancy of cities and enable greater access to shops, commercial activities, and other amenities. However, the window of opportunity to do this in Sub-Saharan African cities may have already closed. It is very difficult to retrofit the institutions required to utilize parking as a TDM measure once widespread uncontrolled parking has been established as the norm.

UK - Parking as a TDM measure. In the UK, the policy adopted by most local governments is to restrict or discourage long-stay (commuter) parking and encourage short-stay parking that is perceived to contribute more to the economic well-being of retail facilities. In most cities in the UK, Private Non-Residential (PNR) parking (i.e., privately owned workplace parking for commuters) makes up some 50 percent of the central area parking stock and is beyond the control of local governments. As most local governments sponsor less than 15 percent of available parking (for short stay use only), they have little influence over commuter parking. In such circumstances, it is not possible to influence car commuting practices by a pricing mechanism.

134. Africa Transport Policy Program (SSATP)/Transitec, Final Reports: *Sustainable Mobility and Accessibility Policy for Kenya's Cities, Urban Areas of Ghana, Urban Areas of Nigeria, Cities of Ethiopia, and Cities of Rwanda*, 2018.

The way forward - strategic interventions to address parking challenges. As Sub-Saharan African cities and other cities worldwide face similar parking problems, the international context for parking reform becomes more relevant. However, the pace of city development and the piecemeal approach to addressing growth can pose issues for implementing reforms adopted by cities in other parts of the world. International cities have good institutional foundations for managing parking thanks to the following practices:

- Reasonable land use policies
- Development control
- Functional Road Hierarchies (FRHs)
- Traffic Impact Analysis (TIA) methodologies
- Centralized vehicle and driver databases

Beijing can also provide useful guidance on this issue through their 2015 Parking Guidebook showing how the city quickly consolidated piecemeal measures into a more comprehensive approach.[135]

Photo by Gift Habeshaw on unsplash.com

135. *https://www.itdp.org/publication/parking-guidebook-for-beijing/* accessed 19 February 2021.

SINGLE PARKING AUTHORITY

Institutions for parking. Cities need to set up a single *parking authority* at the city level to address the different needs of each city and urban area. Establishing a parking authority at a higher level could be inaccessible to the public and could result in unsuitable policies being applied area-wide without consideration for local conditions. The single parking authority must be able to control the location, type, and pricing of parking. Under this system, the management can be overseen by private enterprise and enforcement can be conducted by civilian traffic wardens where parking violations are not criminalized. Box 6.2 shows how Singapore has managed parking.

BOX 6.2: PARKING MANAGEMENT IN SINGAPORE

Singapore is a small island city-state of only 625km^2 and a population of about three million, but it has a progressive range of policies to restrain private cars and improve PT. In the 1960s, central areas of Singapore suffered serious traffic congestion due to the rapid growth of car usage, a poorly developed road network, and inadequate PT. In the early 1970s, the adverse impacts of worsening congestion were recognized, and since then Singapore has implemented a variety of regulatory and pricing schemes to restrain car ownership and usage. Parking management reform has been a central part of this process.

1970s - Lessons learned on parking restraints. As a car restraint strategy, measures to limit parking capacity and improve traffic flow were introduced in Singapore. It was hoped that limits on parking and high fees would deter vehicles from entering the CBD. Contrary to expectations, however, vehicle flows to the area were not reduced, and many vehicles queued for the available parking spaces, causing road blockages and reductions in road capacity. This situation occurred because there was little restraint on car ownership. Those who could afford a car could pay to park. The lesson learned was that isolated measures limiting road or parking capacity to induce a shift to PT or to restrain vehicle usage tended to cause serious problems without achieving public objectives. Parking controls and vehicle restraint measures needed to be implemented as part of an integrated package.

1990s - Parking controls were a key element of transport policy. In September 1998, the Electronic Road Pricing (ERP) congestion charging[136] system was deployed. Parking management was an important element of this form of congestion charging. Exceedingly high standards for parking arrangements, however, were imposed on developers and building owners. The public sector was also active in the supply and operation of parking lots through the process of urban redevelopment. As a result, Singapore had ample parking capacity and central areas had excess capacity. The low incidence of illegal parking contributed to efficient traffic flow despite some obstruction caused by loading activities near wholesale shops. The policy of providing ample off-street parking capacity also contributed to the improved flow of traffic in the central area.

Standards for parking accommodation in Singapore were based on the following principles:

- The required level of parking provision was very high.
- Regardless of their size, all buildings, including residential ones, were required to have sufficient car parks to accommodate all the cars of residents and visitors.
- The level of parking provision and the balance between supply and demand was subject to periodic review and amendment.
- The parking standards did not apply uniformly to the entire urban area and since 1990, different levels of parking standards have been applied to different zones depending on district land use and traffic conditions.

2000s - Stricter enforcement of minimum parking standards. Instituted in 2005, the current parking policy enforces minimum parking provisions on residential developments. The "Parking Places (provision of parking places and parking spaces) Rules" require residential developments to provide just enough parking spaces to serve the demand of their own residents. The minimum requirement for parking spaces was changed to a requirement self-administered by each local entity.

136. Chin Kian-Keong, Road Pricing – Singapore's 30 Years of Experience, CESifo DICE Report 3/2005, 2005.

HIERARCHY OF PARKING ZONES WITH DIFFERENTIATED PRICING

Parking in a Functional Road Hierarchy. Parking is an important road function and should be included in an FRH. The FRH definition should specify the desired type of parking within the context of a zonal system whereby parking is purchased and gets more expensive as the zone gets closer to the city center. Box 6.3 illustrates how this is done in The Netherlands.

Establishing a hierarchy of parking zones. An opportunity to develop a parking management system embedded in an Intelligent Transport System (ITS) is discussed in Box 6.4. This opportunity would implement a zonal system with a hierarchical pricing strategy where it is more expensive to park nearer the city center. The city should control standards involving the number, location, and pricing of parking areas, and the private sector should manage and enforce parking. Parking violations should be civilianized and not become criminal offenses. Parking is, after all, a business, and this should be recognized. A system should operate within a regulatory framework, however, with standardized pricing. Box 6.4 illustrates how Transport for London has developed a hierarchical system based on the levels of PT.

BOX 6.3: PARKING MANAGEMENT IN THE NETHERLANDS

The Netherlands - Hierarchical parking provision - the ABC location policy. To combat urban sprawl and decentralization, the Dutch government adopted a parking policy aimed at concentrating employment-intensive land uses around PT routes and interchanges. This is known as the "ABC Location Policy," and it is based on establishing and then matching definitions of accessibility for locations with definitions of mobility for businesses. To match expectations for mobility and accessibility, businesses with "Mobility Definition A" can only be in locations with "Accessibility Definition A" and likewise for types B and C. This is shown in Table 6.2.

Parking spaces at offices are allocated according to employment levels, usually with a maximum of one space for every two jobs. Oftentimes, the availability of parking spaces is much less than that. In Amsterdam, the parking standard for offices in the city center is zero. Outside the city center, it is only 25 spaces per 100 jobs. Parking demand is further reduced by the TDM policy whereby employers encourage their staff to use the most appropriate mode of travel for journeys to work and other business trips, according to environmental criteria.

Table 6.2:
The Netherlands: Accessibility and Mobility Definitions

Accessibility definitions		Mobility definitions	
A.	1. Main PT interchanges in town centers 2. Easy access by cycling and walking 3. Fast and frequent rail services to other centers 4. Parking for no more than 20 percent of the workforce 5. Supporting "park-and-ride" facilities on feeder routes	A.	1. People-intensive land-uses in relation to the surface area 2. High need for PT
B.	1. PT interchanges in district centers 2. Bus interchanges in small towns 3. Near main trunk roads or expressway junctions 4. Parking for up to 30 percent of the workforce	B.	1. Commercial services such as the clothing industry, instruments and optics, sport, and recreation 2. Social services 3. All kinds of retail services
C.	1. No specific PT requirements 2. Locations within the immediate vicinity of expressway junctions 3. At the edge of urban areas	C.	1. Goods-intensive uses 2. Uses dependent on private transport

BOX 6.4: LONDON PUBLIC TRANSPORT ACCESSIBILITY LEVELS[137]

Public Transport Accessibility Levels (PTALs) have been adopted by Transport for London (TfL) to produce a consistent London-wide Public Transport (PT) access mapping facility. TfL's mission is to assist the London boroughs (i.e., districts) with planning the location and amount of parking by measuring broad PT accessibility levels. This method provides a consistent framework which allows variances in PT accessibility in different parts of London to be considered.

There is evidence that car usage decreases as access to PT, as measured by PTALs, increases. PTALs are used to help determine the location of developments and their parking standards, and they need to be updated regularly, typically on a bi-annual basis with interim updates for certain areas.

TfL uses PTALs to determine the amount of parking required at different types of developments and locations. PTALs are a detailed and accurate measure of the accessibility of a "point to the public" transport network that accounts for walking and waiting times (including reliability and frequency of service). PTAL scores can be calculated on an area basis using GIS (MapInfo) or manually at a site-specific level using an Excel spreadsheet.

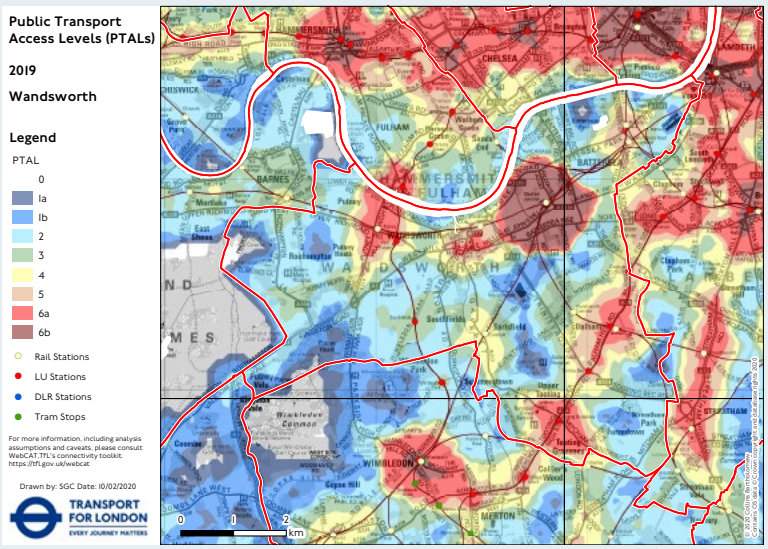
A PTAL calculation assigns a level between "1a" and "6b" representing very low to very high PT accessibility to any given site. TfL has produced a PTAL map which gives a broad picture of the PT accessibility of each borough.

Typical PTAL Methodology. Calculating the PTAL of a site involves several different factors including the proximity of the site to PT stations or stops for different PT modes and routes, and the a.m. peak frequency of those services. A PTAL is typically calculated for the a.m. peak period. PTAL is a measure of public transport accessibility reflecting:

- Access time by walking from the site to the PT point, such as bus stops, metro, and rails stations within a catchment area;
- The number of different services operating at the service access point; and
- The level of service (i.e., average waiting time) with an adjustment for the relative reliability of the transport mode.

Figure 6.1 shows an example of the PTAL mapping for the London Borough of Wandsworth.

FIGURE 6.1:
PTAL Mapping for the London Borough of Wandsworth[138]



In London, the PTALs form the basis for setting maximum town center parking standards and give a range for London boroughs to provide different parking systems that take PT into account. The London Parking Plan Standard forms the basis for parking standards in the Greater London Area and provides guidance that the boroughs should follow. Any variations from this plan need to be clearly justified in a borough parking plan. It is envisioned that these parking plans will provide the opportunity to manage the supply of parking to minimize traffic congestion, integrate PT, and promote town center vitality.

137. https://data.london.gov.uk/dataset/public-transport-accessibility-levels accessed 12 January 2021.

138. Source: http://content.tfl.gov.uk/public-transport-access-levels-wandsworth.pdf accessed 12 January 2021.

Forecasting parking demand and supply. Parking demand/supply is a complex dynamic and it is exceedingly difficult to forecast the need to set parking standards in a given area. There are different kinds of parking which need to be catered for including residential, public, loading, disabled, and taxi parking. Parking should be part of a wider transport strategy and should contribute to encouraging non-car transport such as walking, cycling, and PT. Developing parking standards and increasing the level of parking availability can be used as initial methods of applying TDM.

Parking standards and regulations. Parking standards and regulations are the foundation of any parking management system. Most cities apply minimum parking standards for new developments, and these standards are based on Gross Floor Area (GFA) for different types of development such as residential, office, commercial, leisure, etc. Cities typically experience problems with older developments where there can be little provision for parking. Residential parking (parking at "origin") in older residential blocks often results in on-street parking and a "sea of cars" around the block. At older retail sites which may have evolved without restrictions or may be unplanned, the same issues exist. Parking standards and regulations usually require regular updates to respond to or preempt motor vehicle growth and parking demand.

Mexico City maximum parking standards. Most cities specify minimum parking standards for new developments, especially if they are playing "catch up" to address a perceived lack of spaces. In 2017, however, Mexico City changed its parking standards for new residential developments from a minimum requirement to a maximum requirement.[139] This change was made to address outdated regulations which required developments to include a large allocation of parking spaces for their tenants, thus encouraging greater car use. The mayor found that more than 40 percent of the floor area for new developments was being allocated for off-street parking rather than for housing, PT, and public space. This innovative approach shows how parking can be used as a Transport Demand Management (TDM) measure. This approach is used in London.[140]

Parking fees/charges. Some governments may view parking as a "cash cow" that generates surplus revenue to finance other local government services. Parking charges are potentially powerful tools, and decisions on charges should be based on reliable estimates of their impact. Therefore, public transparency and accountability of these parking charges must be achieved. Local governments need to keep detailed information on parking usage and monitor it annually; this information should be used to refine the charging system and forecast future changes in parking demand and patterns.

Parking benefits. San Diego, USA illustrates a case where revenue from parking goes directly to the local area. The city's off-street parking lots also generate electricity from solar power. See Box 6.5.

SMART PARKING AND PARKING AS A BUSINESS

Parking Guidance Systems (PGS) and Smart Parking Systems. PGS and smart parking systems are typically part of a city-wide ITS. They consist of an operation and management platform for parking, integrating on-street, off-street, and public parking information in the city. A system typically includes the coding of parking spaces, real-time availability monitoring, PGS to direct vehicles to vacant parking spaces, electronic payment, and customized parking space search and booking services. An example of a smart parking system is given in Box 6.6.

Developing parking as a service and business. Local governments in Sub-Saharan African cities typically try to increase the supply of public parking lots through the construction of stand-alone, independently operated, public multi-story car parks. However, there are many impediments to attracting the private sector to invest in parking lots. These include the following issues:

- Problems of competing parking – cheaper (or free) and more convenient on-street parking near the off-street car park
- Imbalance between on-street charges and off-street charges
- Long investment recovery period ranging from 20 – 40 years
- Insurance matters including the car park owner being responsible for the parked vehicle if it is damaged or stolen.

139. https://www.itdp.org/publication/cdmx-less-parking-more-city/ accessed 19 February 2021.

140. https://www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan/london-plan-chapter-six-londons-transport-0 accessed 22 February 2021.

BOX 6.5: USA, SAN DIEGO: PARKING BENEFIT DISTRICTS (PBDs)

PBDs use parking meter revenue to fund local streetscape, transportation, and infrastructure projects. In cities without PBDs, parking meter revenue goes into a general fund or, in cities where the municipality does not manage the meters, to a third-party corporation to which the city sold the rights. In cities with PBDs, however, the city splits the revenue with the community in which the meters are located. San Diego, California has five PBDs that aim to leverage the significant parking revenue of the densely populated neighborhood toward streetscape improvements and traffic calming.[141]

Off-street parking lots can produce revenue by using shade canopies to generate solar power. The large areas of ground level parking lots provide the open space which can be used for the dual purpose of parking and solar power. For example, San Diego in the USA has an untapped 500-megawatt solar potential at commercial sites within the city, with parking lots representing 75 percent of the total.[142]

BOX 6.6: SMART PARKING SYSTEM IN MADRID, SPAIN[143]

In 2014, Madrid introduced an on-street smart parking system with higher fees for cars that pollute more than others. The objective was to ease pollution levels in the city and to discourage motorists from driving into the city center. Electric cars could park for free, and hybrids got 20 percent off the standard parking fee. Furthermore, the parking fee is variable with charges based on demand and time of day.

The system consists of parking sensors which are embedded in the carriageway to detect in real time whether a parking bay is occupied and the duration of the occupation. Data is sent to a dedicated parking app and to a control center which integrates the parking management systems with other smart transport systems controlling the ATC system, traffic flows, and E-enforcement cameras.

141. https://cleantechnica.com/2019/01/18/san-diego-has-vast-solar-parking-lot-potential/ accessed 8 December 2020.

142. https://www.mainstreet.org/howwecanhelp/navigatingmainstreets/nutsandbolts/smartparking/sandiego accessed 8 December 2020.

143. https://www.nedapidentification.com/cases/nedap-teams-up-with-wairbut-for-on-street-parking-in-madrid/

These problems are not new. These problems were first encountered in developed countries in the 1960s and in Hong Kong in the 1970s – and they were solved by providing incentives to attract private sector investment in public car park construction. These incentives were not special terms or loans or tax breaks; rather they constituted a solid foundation for a single parking authority to provide appropriate parking zones with an appropriate balance between off-street and on-street parking, proper enforcement, and proper pricing. This foundation, together with a developed insurance industry (which meant that car owners insured themselves against damage and theft as opposed to the car park operator), resulted in viable parking businesses in European and Asian cities.

International practice of parking as a service and business. Parking in international cities is usually managed as a service and a business. The number and location of spaces and the level of parking fees are typically set by the local government. Parking management is usually provided by a private company that should be able to make a fair profit from the business.

Table 6.3:
Differences between Criminalized and Civilianized Parking Enforcement Schemes for On-street Parking

Parking Enforcement Procedures	Criminal scheme	Civilianized Parking Enforcement (CPE)
Traffic regulation orders and traffic management	Made by local government under national legislative powers	Made by local government under national legislative powers
Penalty (violation) type	Parking violations	Parking contravention (for example, in the UK this is termed a Penalty Charge Notice - PCN)
Enforced by	Traffic police	Local government parking wardens/private sector operating for local government
Enforcement process	Fixed penalty notice on car windscreen; court summons; wheel-clamping; tow-away of vehicle	PCN on car windscreen; wheel-clamping; tow-away of vehicle
Fine (penalty)	Fixed penalty without reduction for early payment	PCNs with percentage reductions for quick payments (say 50 percent reduction for payments within 14 days)
Liability to pay a fine	Driver liability with the presumption that the owner was the driver	Car owner liability
Pursuing unpaid fines	Can be chased up by post/online through a national database in which all car owners must register	Can be "chased up" by post/online through a national database in which all car owners must register
Repercussions for the car owner of the failure to pay a fine	Increased fine; imprisonment	Increased PCN; civilian law officers can "chase up" fine through lower court.
Initial challenges by the car owner to a fine	Letter to the police	Representations to local government
Further challenges by the car owner to a fine	Trial in a lower court	Tribunal – an appeal to a civilian adjudicator
Who keeps the revenue from fines?	Because the parking fine is a court fine, it goes to a national government finance bureau for overall government funds.	Parking fines are retained by local government. It is recommended that this is "ring-fenced" for further parking and transport investments.

ROADMAP FOR A "PARKING TURNOVER MAKEOVER"

Foundations for parking as a service and business. The best ways to provide incentives for the private sector to construct and operate off-street public car parks include the following foundational factors:

- Carry out a Best Value Review to determine why parking is being provided, who are the target users, and whether the parking facilities are competitive.
- Set up a Single Parking Authority (SPA).
- Ensure that parking charges are balanced, and that off-street parking is cheaper than on-street.
- Ensure that local government is in control of charging structures (the relationship between on-street and off-street) but not necessarily actual charges.
- Solve the insurance issue by setting up a Third-Party Insurance (TPI) for car owners so that insurance is fully comprehensive (meaning that any off-street car park owner would not be responsible for theft or damage but that the car owner could claim damages from their insurance policy, as is the case in most developed countries).
- Explore options for private management of car parks under contract to local government.
- Explore options for private ownership with local authority over conditions of use, enforcement, and parking fee structures.

Best Value Review. Parking as a business should be subject to a Best Value Review providing answers to the following questions:

- Why is the parking being provided?
- What is the justification for the service being provided by the local government or private developer?
- Are current parking fees appropriate in relation to costs and potential revenues?
- How does the performance, quality, and cost compare with parking operations in other local governments?

A Best Value Review generally needs data for the following: parking usage, including turnover of spaces, daily totals, peaks, staff costs, costs and income generated per parking space, information on parking fines, and the recovery rate of fines issued.

A single parking authority. Any parking business plan should recognize the relationship between charging levels for on-street and off-street spaces and the potential interaction between the two. This becomes difficult if different agencies are involved in parking, and a lot easier if there is just one parking authority. Another problem is presented by Private Non-Residential (PNR) spaces made available by companies for their commuting employees to park all day.

The parking account. The core of the business plan is the parking account which enumerates all income and expenditures. By bringing together all the parking associated costs in the account, any subsidies, cross-subsidies, or privileges for certain users are exposed; these will require justification in the business plan. In addition, parking expenses can be compared with the costs of other transport services so that priorities can be better determined. The largest element of the parking account is probably the income generated by parking charges. The second largest element will probably be parking fines.

Additional revenue generated by parking. Additional revenue from both public and private car parks can be generated by the following:

- Contract parking provided on an annual basis for companies
- Contract parking in city center locations in the evening and weekends for residents who have their own spaces
- Advertising on the reverse of parking tickets
- Internally illuminated advertising
- Use of the car park for temporary activities
- Car washing (this also provides a presence, giving a feeling of security)
- Vending machines
- Sponsorship.

Civilianization of enforcement. Enforcement of parking can be provided by civilian staff, leaving the traffic police free for other duties. Previously, in many countries, local authorities traditionally looked to the police for most forms of enforcement including parking enforcement. But more specialized staff can fill some of these tasks, leaving the police to do more difficult tasks. There has been a move away from the use of police to traffic wardens for parking enforcement. Some traffic wardens are under police control, others are employed by local authorities. A key benefit is that the parking fines (penalties) can be ring-fenced by the local authority for transport purposes instead of going into a general local authority pot. Table 6.3 shows the differences between criminalized and civilianized enforcement schemes.

Photo by Michael Muli

Table 6.4 summaries key aspects of parking management development and implementation.

Table 6.4:
Parking key features with *preferred options in italics*

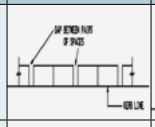
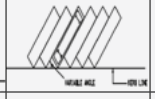
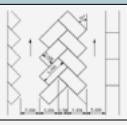
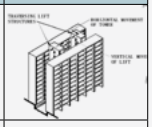
FEATURE	OPTIONS						
Location	**On-street**			**Off-street**			
Design	**Parallel**	**End-on**	**Diagonal**	**Ground level**	**Under-ground**	**Multi-story**	**Mechanical**
Example of Design							
Determination of Location/ Zone/ Type/ Charging	*Government*	*Government*	*Government*	*Government*	*Government*	*Government*	*Government*
Ownership Options	*Public*	*Public*	*Public*	Public	Public	Public	Public
				Private Sector	*Private Sector*	*Private Sector*	*Private Sector*
				Household	Household	Household	Household
Control of Use/ Management Options	Uncontrolled	Uncontrolled	Uncontrolled	X	X	X	X
	Government	Government	Government	Government	Government	Government	Government
	Private Sector	*Private Sector*	*Private Sector*	*Private Sector*	*Private Sector*	*Private Sector*	*Private Sector*
Availability Options	Public	Public	Public	Public	Public	Public	Public
	Public subject to conditions	*Public subject to conditions*	*Public subject to conditions*	*Public subject to conditions*	*Public subject to conditions*	*Public subject to conditions*	*Public subject to conditions*
	Private	Private	Private	Private	Private	Private	Private
Charging	Free	Free	Free	Free	Free	Free	X
	Charged	*Charged*	*Charged*	*Charged*	*Charged*	*Charged*	*Charged*
Enforcement	Traffic Police	Traffic Police	Traffic Police	Traffic Police	Traffic Police	Traffic Police	Traffic Police
	Civilian Wardens	*Civilian Wardens*	*Civilian Wardens*	*Private Sector*	*Private Sector*	*Private Sector*	*Private Sector*
Freight; Loading/ Unloading Bays	*Night-time*	*Night-time*	*Night-time*	*Night-time*	*Night-time*	X	X
	Day-time	Day-time	Day-time	Day-time	Day-time	X	X
Paratransit; Rank Options	*Parallel*	End-on	Diagonal	X	X	X	X
Taxi Rank Options	*Parallel*	Generally, not suitable	Generally, not suitable	X	X	X	X

Table 6.5 presents a roadmap and timeframe for tackling parking problems in Sub-Saharan African cities.

Table 6.5:
Roadmap of Strategic, Operational and Tactical Tasks for Parking Management

EASI Framework	Functional Road Hierarchy	LEVEL	TIMELINE
SHIFT	**Develop a parking management system and utilize parking as a Transport Demand Management (TDM) measure to SHIFT the focus away from motorized modes.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• International cities had good institutional foundations for managing parking because of the following factors: (1) reasonable land use policies; (2) development control; (3) Functional Road Hierarchies (FRH); (4) Traffic Impact Analysis (TIA) methodologies; (5) trip rates; (6) centralized vehicle and driver databases. • Local experience of Maputo and Addis Ababa as a "bottom-up" initial small step approach. • Forecasting parking demand. • Developing parking standards. • Smart parking, cashless parking, crowdsourced parking. • Mechanical parking systems, Parking Guidance Systems (PGS). • Parking as a business. • Parking benefits system.	STRATEGIC	MEDIUM TERM
2. Develop a parking strategy for Sub-Saharan African cities.	• Establish a zonal parking system with a differentiated and hierarchical charging system. • Develop parking standards including a PTAL approach, • Systematic pricing/charging policy.	STRATEGIC	MEDIUM TERM
3. Develop conceptual parking management plans for Sub-Saharan African cities.	• Establish a zonal parking system with a differentiated and hierarchical charging system. • Develop parking standards including a PTAL approach. • Systematic pricing/charging policy	TACTICAL	MEDIUM TERM
4. Investigate the potential of Parking Guidance Systems.	• Intelligent Transport Systems (ITS) for parking and Parking Guidance Systems (PGS) and smart parking systems.	TACTICAL	MEDIUM TERM
5. Develop a parking business plan.	• Develop parking as a business and a service. • Privatization of management. • Public/private partnerships. • Civilianization of enforcement.	OPERATIONAL	MEDIUM TERM

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7.

TECHNICAL NOTE FIVE

GUIDELINES FOR DEPLOYING INTELLIGENT TRANSPORT SYSTEMS (ITS)

- *The case of Gaborone, Botswana.*
- *Smart cities. Smart mobility.*
- *The latecomer advantage.*
- *User centric, data-driven, bottom-up innovations.*
- *Area Traffic Control as the foundation.*
- *Roadmap to ITS*

IMPROVING safety and efficiency through Intelligent Transport Systems (ITS) may seem to be a distant achievement for Sub-Saharan African cities, especially those cities with few sets of traffic signals that work mainly in isolated modes with simple phasing. Yet these cities can benefit from the "latecomer advantage" to leapfrog to the latest technologies in ITS such as crowd-sourced smartphone transport applications and on-street area traffic control. The fifth theme of this report is that ITS are achievable and affordable for developing cities which can quickly implement them to enable safer and more efficient traffic flows with better provisions for NMT. Advances in technology mean that cities can not only take advantage of the latest technologies for on-street equipment such as multi-phase traffic signal controllers and above-ground vehicle detection, but they can also deploy the technologies in a step-by-step manner. Even within a ten-year timeframe,[144] for example, Area Traffic Control (ATC) can be deployed step-by-step without the need to use all of its functions initially. ATC is a core function of ITS and would be deployed in the following way: first in isolated modes with simple phasing, followed by more complex phasing, next with sub-area coordination, then with full area coordination, and finally, fully adaptive ATC.

In Sub-Saharan Africa, the pace of urbanization over the last 60 years has been unprecedented. The continent will continue to have the fastest urban growth in the world; Africa's population is projected to double between 2020 and 2050 with 66 percent of this growth occurring in urban areas.[145] Urban life has become increasingly "smart." Worldwide, cities are jostling to be the "smartest" with a myriad of initiatives aiming to take advantage of the large volumes of data that are becoming available. This is evident not only in the use of emerging technology at work and at home but also in people's interactions within the city. Cities are taking a diverse mix of tentative steps and big leaps towards realizing the power of technology and data.

LESSONS LEARNED FROM AREA TRAFFIC CONTROL IN GABORONE, BOTSWANA: ITS NEEDS THE "THREE E'S"

The Gaborone Integrated Transport Project financed by the World Bank includes an ITS system for the city, the basis of which is an adaptive Area Traffic Control (ATC) system.[146] This system is comprised of 129 signalized junctions, a fiber-optic communication network and a Traffic Command Center (TCC). The project also envisions the installation of cameras for monitoring, traffic counting and enforcement. Installation of on-street traffic signal equipment is ongoing and the whole system is scheduled for completion by early 2022.[147] The World Bank financed not only the procurement and installation of the equipment but the development and design of the

144. Typically, the lifecycle of ITS equipment in fast emerging Asian economies.

145. https://www.oecd-ilibrary.org/development/africa-s-urbanisation-dynamics-2020_b6bccb81-en accessed 8 December 2020.

146. The World Bank, September 2020, Integrated Transport (P102368) Botswana, *Restructuring of Integrated Transport approved on May 28, 2009 to Ministry of Finance and Economic Development*, Report No: Res42790.

147 The World Bank, December 2020, Implementation Status & Results Report, Integrated Transport (P102368), AFRICA EAST | Botswana | Transport Global Practice |IBRD/IDA | Investment Project Financing | FY 2009 | Seq No: 24 | ARCHIVED on 08-Dec-2020 | ISR43959.

system itself. The project design also recognized the importance of the "Three Es" - Engineering, Education and Enforcement - as essential complements to the ITS equipment. However, only the engineering component is currently being carried out in the form of physical junction channelization using good geometric design to direct traffic in efficient paths through the traffic signals.

Deficiencies addressed. Deficiencies were identified regarding the education of drivers and the enforcement of the new traffic signal phasing. Local newspapers[148,149] document how drivers have been confused by the phasing of new traffic signals, most notably where several traffic movements run parallel to each other and traffic signal timings are not able to adapt to certain traffic conditions. In the past, drivers were used to disobeying traffic regulations and disregarding traffic signals. The Botswana Traffic Police plans to tackle these issues through stricter enforcement and a wider education campaign. A lesson learned is that while ITS are the future for developing cities, they are not a panacea to solve traffic congestion; there is still a need to implement ongoing complementary measures focused on the "Three Es."

Traffic Command Centers in Sub-Saharan Africa and benefits of external funding. Cape Town is one of the few Sub-Saharan African cities to have a developed a traffic command center, termed the "Traffic Management Center" (TMC) which integrates traffic management, road safety, PT, and city security in one controlled place.[150] However, the establishment of the TMC was only possible with external funding as a 2010 FIFA[151] World Cup legacy project.[152] Leveraging the power of international events, especially sporting ones, can often be a catalyst for transport improvements as can be seen worldwide with the Olympic Games, for example. The TMC brought together freeway management, urban traffic control, transport information centers, integrated rapid transit, traffic services, and metro police to function side-by-side in one operational environment designed and built to meet and exceed world standards. Cape Town has continued to develop its TMC and its on-street ITS equipment; as of 2021, the city has more than 1,500 signalized junctions which cater for both motor vehicles, pedestrians, and non-motor vehicles. All signal aspects use the latest technology LED lights for sustainability and operational efficiency.[153]

SMART CITIES AND SMART MOBILITY

Smart mobility. Getting around cities is becoming more "seamless" with smartcard payments for parking and PT, and crowd-sourced smartphone applications (apps) for transport. Traffic management can be significantly improved and given high status by leveraging a smart city approach which deploys Intelligent Transport Systems (ITS).

ITS. The latest traffic management techniques use the power of evolving ITS technologies. ITS are transforming transport systems and the road user experience through individual smartphones and computers, sensors, and communications technology that use on-street and in-vehicle equipment. Such systems enable safe, convenient, energy efficient, and seamless journeys.[154] ITS are comprised of hardware and software tool packages that include but are not limited to infrastructure planning and maintenance, traffic enforcement, financial transactions, emergency services, incident response, travel information, traffic guidance, parking, freight and fleet management, PT management, and intelligent vehicles.

ITS experience in Asian cities. Seoul in South Korea, Singapore, and various cities in China illustrate what can be achieved with comprehensive and integrated ITS. These cities started from a low base with few traffic signals and their ITS development coincided with evolving technologies. Since Seoul and Singapore were at the forefront of ITS development, they could not benefit from the latecomer advantage of learning from cities that tested the new technological solutions. Figure 7.1 illustrates recent advances in Seoul and Singapore.

148. The Midweek Sun, 3 February 2021, accessed online on 15 February 2021.

149. *https://yaronafm.co.bw/2020/10/30/road-users-urged-to-be-cautious-around-traffic-lights-under-maintenance-in-the-greater-gaborone-area/* accessed 15 February 2021.

150. *http://www.securitysa.com/44927n* accessed 9 April 2021.

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152. *https://www.fifa.com/worldcup/news/fifa-launches-2010-fifa-world-cup-legacy-trust-for-south-africa-1350917* accessed 24 April 2021.

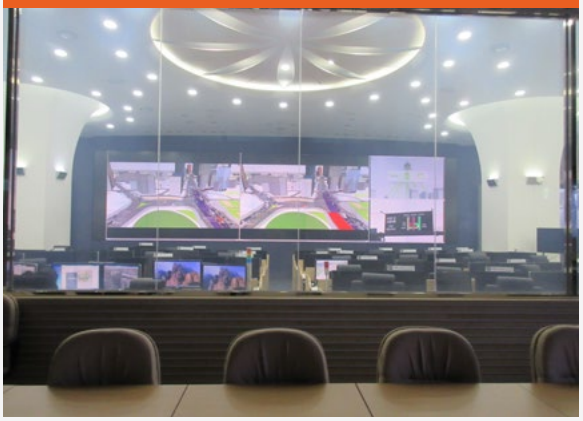
153. *https://www.tct.gov.za/en/transport/transport-network/traffic-signals/* accessed 25 April 2021.

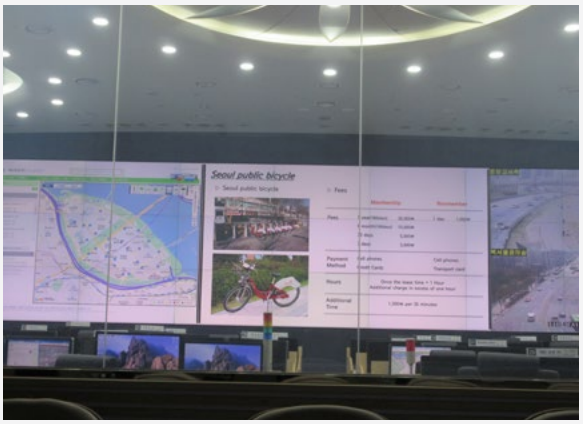
154. Chen, Yang et al, 2016. Achieving Energy Savings by Intelligent Transport Systems Investments in the Context of Smart Cities, WCTR, Shanghai 10 – 15 July 2016.

FIGURE 7.1:

Seoul and Singapore Traffic Command Centers for ITS[155]

South Korea, Seoul: Transport Operation and Information Service (TOPIS) which has functions beyond transport, including city safety and security





Singapore: Traffic Command Center

THE LATECOMER ADVANTAGE

Developing cities can benefit from adopting ITS later. Such cities can leapfrog to the latest, most appropriate technology for their needs without having to go through the prior development stages of ITS technology that older cities have experienced. This includes crowd-sourced smartphone applications together with user-centric, data-driven and bottom-up innovations.[156]

USER CENTRIC, DATA-DRIVEN, BOTTOM-UP INNOVATIONS

User-centric innovations. In user-centric transport, the focus is on people rather than vehicles. Smartphone applications can enable the user to potentially access a wide range of transport options such as PT, taxis, shared taxis, and public bicycles instead of private motor vehicles. Data and

155. Source: Photos of TOPIS by author, Seoul, South Korea, 2015, https://topis.seoul.go.kr/eng/english.jsp accessed 13 January 2021; Photos of Singapore by author, Singapore, 2015.

156. Chen, Yang et al, 2016. Achieving Energy Savings by Intelligent Transport Systems Investments in the Context of Smart Cities, WCTR, Shanghai 10 – 15 July 2016.

information on traffic flows, speeds, incidents, and weather gathered from Traffic Command Centers (TCC) can be transmitted to the user on-street and in-vehicle to help them make decisions about their journey. Finally, the scope for smartphone-enabled financial transactions is poised to expand for payments such as PT journeys, parking charges, and penalties for traffic violations. Chen *et alia* have stated, "Smart mobility aims to make users not just consumers of services, but also producers of such services— 'prosumers'—who would 'co-create' these mobility services with the government, operators, or other stakeholders."[157] This raises the potential for an "alignment of interests"[158] between the public and private sectors unlike traditional ITS.

Data-driven innovations. In transport, "Big Data" has the potential to transform transport and give services flexibility to respond to rapid changes in traffic conditions. Big Data is collected through several sources including individual smartphones, equipment centralized in the TCC, equipment installed on-street and equipment fitted in-vehicle. Examples of data collection devices include CCTV monitoring cameras, E-police enforcement cameras, ATC detectors, satellite-positioning devices, satellite navigation (satnavs), and smartphones. The collected data are locational and are generated in real-time or near real-time. For example, data from an adaptive ATC system can be used to respond to traffic conditions or to predict and influence traffic flows. Big Data can also match demand with supply, and thus provide a springboard for shared paratransit efficiency. Another example is from Freetown Sierra Leone (see the fifth paragraph of Chapter 3) where the World Bank's Integrated and Resilient Urban Mobility Project (IRUMP) is utilizing mobile phone Call Data Records (CDR) along with data on flooding, poverty, transport supply and demand together with information from the health, education and tourism sectors to investigate the range of traffic patterns for all road users during different weather conditions, especially flooding events.[159]

Big Data in Cape Town. Smarter transport is becoming a key driver for creating smart cities and these technologies are being utilized in Sub-Saharan African cities, such as Cape Town, Johannesburg, Lagos, Nairobi, Addis Ababa, Dar es Salaam and Maputo. Big Data has many applications worldwide, so harnessing it to improve informal and unregulated PT operations in Sub-Saharan Africa makes sense to transport authorities. PT services rarely run on a timetable, with vehicles departing when they are full. Routes are mostly spontaneous and stops occur wherever they drop off passengers or collect more passengers. Cape Town has taken a strategic step to regulate transport operations by establishing the Transport and Urban Development Authority (TDA). The TDA combines the functions of integrated transport, urban development, and elements of human settlements into a single governmental body that dramatically improves efficiency and focuses on the spatial transformation of Cape Town. Using a range of Intelligent Transport Systems (ITS) and Big Data solutions, the city is setting a high bar for other municipalities and metro areas on how to improve mobility.

Useful information platforms. Two local ITS companies receiving international recognition are developing building blocks to make transport work smarter and help commuters plan their trip from door to door. WhereIsMyTransport (WIMT) and GoMetro are open information platforms that collate PT data for both formal and informal services and combine their data with analytics and communication tools.[160] These tools have been specifically tailored for transport in emerging economies. As these apps require data reception, Cape Town has a program to improve its mobile phone reception and ensure city-wide Wi-Fi is available for citizens. As of 2018, data from Cape Town's formal and informal transport system is captured, integrated, and openly available.

Table 7.1 summarizes the potential for collecting Big Data in the case of Sub-Saharan Africa.

Bottom-up innovations. In developed cities, ITS are typically top-down interventions. This has been the traditional curve of ITS development where a centralized TCC controls the on-street ITS and collects data from on-street and in-vehicle equipment, thus directly controlling traffic. This requires cooperation across different agencies such as the traffic police, roads and transport departments, urban construction departments,

157. Ibid.

158. Ibid.

159. https://blogs.worldbank.org/transport/through-technology-and-creative-thinking-african-youth-are-reinventing-future-urban
https://blogs.worldbank.org/opendata/how-urban-mobility-data-transformed-freetown
https://blogs.worldbank.org/transport/africas-students-can-transform-future-transport-lets-invest-them-0 accessed 1 April 2021

160. https://www.intelligenttransport.com/transport-articles/65503/big-data-improve-cape-towns-transport/ accessed 9 April 2021.

Table 7.1:
Potential Big Data Sources for the Sub-Saharan Africa Situation[161]

Big Data Sources	Systems	Devices	
		Public	Private
Mobile-based generated data	Satellite positioning systems	Fleet tracking: • Bus AVL • Taxis • Paratransit • Motos	Fleet tracking: • Taxi • Motos • Ridesharing services
		Floating vehicle data especially on taxis, motos and paratransit	In-vehicle navigation systems
	Mobile phone locational and other data	Mobile phone towers; satellites	Mobile phone towers; satellites
	Mobile phone apps	Mobility as a Service (MAAS)	Mobility as a Service (MAAS); financial services
	Crowd sourced data	Smartphones: • Tweets (such as Twitter, Wechat APIs) • Locational check-ins (such as Foursquare)	Smartphones: • Tweets • Micro-blogs • Locational check-ins • Photos
Automatic Data Collection Systems	Fare collection	Public transport ticketing: • Smart cards • Contactless payments	Public transport ticketing: • Contactless payments
		Electronic road pricing; congestion charging	-
	Automatic passenger counts	In-vehicle (buses) boarding/alighting	-
		BRT stations	-
Physical Sensors	Network sensors	CCTV cameras: • Monitoring cameras • E-police enforcement cameras • Automatic number plate recognition	CCTV cameras • Monitoring cameras
		Bluetooth detection	-
		• Detection for ATC such as inductive loops, above-ground video detections, microwave, radar, radio • Pedestrian detection at pedestrian crossings	-
		Environmental sensors for temperature, noise, air quality	-
		Parking meters; parking sensors in-ground and above ground	-
	In-vehicle sensors	Bus, truck, taxi, paratransit, and moto monitoring sensors: • Driving performance • Fuel consumption • Engine temperature • Speed • Location, route	Private car: • Driving performance • Fuel consumption • Engine temperature • Speed • Location, Route

161. Adapted and extended by the author from: The World Bank, Big Data for Development Primer Series – Sector #1: Transport and Mobility, September 2014.

finance bureaus, etc. This issue can be challenging enough for developed cities given the often-siloed structure of city governments,[162] but such a top-down approach has the potential to pose even more problems for evolving cities in Sub-Saharan Africa. Bottom-up innovations can thrive where smart mobility is powered by the needs of citizens, private companies, and small start-ups, where transport service is provided with lower costs to cities, and where "the business model is based on the revenue-generating potential of the user base and data."[163]

Transport apps and the "Uberization" of Mobility as a Service in Africa. There is a growing realization in Sub-Saharan African cities about the power of transport as an enabler and key driver for transformation. The principles behind mobility as a service are helping transport authorities and operators shift the focus away from competing operators on different modes toward a people-centric model.

The core of "Mobility as a Service" (MaaS)[164] in many Sub-Saharan African cities is demonstrated by motorcycle taxis. The expansion of motorcycle services is occurring at the same time as the entrance of "Uber" type services for taxis in Maputo, Mozambique[165] and Accra, Ghana.[166] In East Africa, these vehicles are known as "boda bodas," "okadas," "moto-taxis," or simply "motos." Motos not only fill a huge gap in the provision of individual transport-on-demand but also provide employment (mainly for young men).

Examples of moto apps include: Gozem, launched in Togo in 2018 and now expanding to West and Central Africa; MAX.ng in Nigeria; and SafeMoto, YegoMoto and SafiRide in Rwanda. The apps are typically linked to motorcycle manufacturers. Furthermore, they are expanding their sphere of influence into financial transactions, following the course of Chinese apps such as Alipay and Tencent but trailing behind those in East Asia by about ten years.[167]

Potential expansion of motos. There is potential to expand the role of motos beyond ad hoc point-to-point provision into more regulated feeder services between suburbs and city centers. Regulation was previously considered the key[168] to achieving this but it has faltered with countries flip-flopping on restriction and prohibition policies. Recent trends have seen the emergence of a myriad of transport apps, all vying for prime position in the African market, as a potential gateway to regulation. Another reason for greater regulation is the potential for improving the safety of motos, which have been notoriously unsafe for both riders and passengers.

AREA TRAFFIC CONTROL AS THE FOUNDATION

Traffic signals and Area Traffic Control (ATC) are at the heart of ITS for developing cities. The building blocks of ITS are traffic signals and ATC systems. ATC is a system of coordinated traffic signaled junctions which can adapt to traffic volumes, respond to traffic patterns, and set priorities for different transport modes such as Public Transport (PT), paratransit, and Non-Motorized Transport (NMT) including pedestrians. ATC systems are visible and viable on-street measures and can be developed from single sets of traffic signals which are initially deployed in isolated modes with simple phasing. This is then followed by more complex phasing, sub-area coordination, full area coordination, and finally fully adaptive ATC.

Importance of traffic signals. ATC can be a "low hanging fruit" for instituting smart solutions along with smart bins and smart street lighting which are relatively easy to adopt. To develop ATC systems, however, a city first needs traffic signals. Cities in Mali and Niger, for example, have few signalized junctions, so an initial first step could be to install simple sets of traffic signals operating in isolated modes. Modern traffic signal controllers usually have the built-in capability to be easily upgraded to work in a coordinated manner at a future date.

162. Ibid.

163. Ibid.

164. https://www.sutp.org/publications/mobility-as-a-service-maas-inua-7/ accessed 19 February 2021.

165. https://www.petitfute.co.uk/v52067-maputo/c1122-voyage-transports/c1145-avion-bateau-bus-train-taxi-parking/c915-taxi-vtc/1620164-zip-taxi-app.html accessed 19 January 2021

166. https://www.ghanaweb.com/GhanaHomePage/business/Fameko-Taxi-App-launches-in-Accra-with-special-offer-for-drivers-and-riders-707946 accessed 19 January 2021

167. https://www.bbc.co.uk/news/world-africa-50228185 accessed 11 January 2021.

168. Kumar, Ajay, SSATP Discussion Paper No. 13 Urban Transport Series, *Understanding the emerging role of motorcycles in African cities, A political economy perspective,* The World Bank, 2011

Photo by Ayoola Salako on unsplash.com

Cascade effect of ATC. As a key element of traffic management, ATC systems can be a catalyst for other traffic management and ITS measures while enhancing the status of traffic management. The cascade effect of ATC systems can reduce emissions and improve air quality. Improved junction control using traffic signals can reduce exhaust emissions as it is at these locations where emissions are most likely to be generated through vehicles starting, stopping, and queueing with idling engines. ATC systems are also a force for good in the protection of vulnerable road users where they can be used to implement bicycle priority measures and provide safe crossing points for pedestrians. The benefits of ATC systems may not be immediately obvious until the system is switched off or suffers a technical failure.

International experience of ATC. In the city centers of developed countries, traffic signal coordination is standard practice. In the UK for example, it is expected that more than 40 percent of traffic signals, including pedestrian crossings, will eventually be deployed in coordinated signal systems. In London, 6,300 are signalized out of around 20,000 junctions, a signalization rate of 38 percent. As in most cities, London's signals are part of an ATC system with many operating independently in isolated modes using Fixed Time (FT) plans or isolated Vehicle Actuation (VA). In Wuhan, China, over half of nearly 2,500 traffic signals are in an ATC system. In most North American cities, there are typically 1,000 to 2,000 persons per signalized junction and slightly more in Western Europe.[169] In general, it is considered that any city with over 100,000 inhabitants would benefit from ATC.[170]

Objectives for ATC. Key objectives for instituting ATC systems include influencing and responding to traffic patterns and adapting or responding to traffic. In a fixed time system, an ATC system can be used to influence the pattern of traffic. It can also attract or deter traffic to and from particular routes or areas, give priority to specific categories of road users, and arrange for queueing to take place in suitable parts

169. World Bank, 2007. Advance Traffic Management Systems (ATMS) in Urban Area, Dubé, A M et al, Transport Notes, Urban Transport Thematic Group.

170. Ibid.

of the network where, for example, the noise and fumes of waiting vehicles would cause less impact or where convenient road space exists for queueing. ATC systems can also be used to adapt or respond to existing traffic conditions, where traffic volumes and flow patterns determine the signal settings within predetermined maximum and minimum settings for cycle times and green splits. There is a range of objectives for cities to consider when choosing an ATC system and these are much broader than merely reducing delays and stops for vehicles.

Benefits of ATC. Good ATC systems can make the best use of existing network capacity and reduce journey times without creating adverse environmental effects. By reducing congestion and delays, they can help in lowering vehicle noise and pollution. ATC systems can provide the basis for expanded ITS by incorporating variable message signs, congestion monitoring, and emergency vehicle priority protocols. ATC systems can also be catalysts for other traffic management techniques and can enhance the status of the traffic management system. In conjunction with other traffic management techniques, ATC programming can provide a cost-effective and efficient means of implementing a range of flexible traffic management strategies.

The potential benefits of ATC are summarized in Table 7.2.

A summary of key benefits worldwide of ATC from a range of cities is given in Table 7.3.

Table 7.2:
Benefits of Area Traffic Control (ATC) as a Key Foundation for Intelligent Transport Systems (ITS)

Improving urban form enabling a human scale for cities	• A potential to make the best use of the existing network. • To enable a more human scale to evolve for cities by deferring or precluding the need for costly new road infrastructure. • To enable a more human scale to be achieved for cities by incorporating at-grade signalized crossing facilities for pedestrians and bicycles without the need for grade-separation.
Catering for all road users including vulnerable ones	• To optimize the traffic performance of a network or selected corridors for all traffic modes including NMT (pedestrians and cyclists). • To give priority to specific categories of road users especially buses, bicycles and emergency vehicles. • To promote a more pedestrian friendly environment by using ATC to provide at-grade crossings for pedestrians with the minimum impact on motor vehicle traffic.
Alleviating congestion and pollution	• To alleviate congestion by reducing delays and reduce the number of times that vehicles must stop. • To balance the capacity in a network by attracting or deterring traffic to/from particular routes or areas. • To arrange for queueing to take place in suitable parts of the network where noise and fumes of stationary traffic would have less impact or where there is space for queueing. • To alleviate environmental pollution by reducing the number of times that vehicles must stop, thus reducing fuel consumption, noise from queueing traffic and air pollution from exhausts.
Enabling specific traffic management strategies	• To enable the implementation of a range of flexible traffic management strategies for an area or city, particularly relevant in cities where traffic growth is rapid and traffic patterns are constantly changing. • To influence traffic patterns in an area (typically done by fixed time systems). • To respond and adapt to traffic patterns (traffic adaptive systems).
Providing the basis for ITS	• To provide the basis for ITS with an expanded control system which could include traffic guidance, electronic enforcement, congestion monitoring, incident detection, fault monitoring, maintenance management, parking. • With traffic adaptive systems, a continually up-dated traffic database is created.

Table 7.3:
Benefits of ATC Worldwide

Country/City Type of ATC/Year	Compared against	Journey time reduced by	Delay reduced by	No. of stops reduced by	Environmental Indices
US/New York MiM/2015	Unknown	10%			
Australia/Sydney SCATS/2015	SCATS Fallback mode	28%		25%	NO_x reduced by 13% CO_2 reduced by 15% PM_{10} reduced by 15%
UK/London SCOOT/2012	Fixed Time TRANSYT		13%		
UK/London SCOOT/2009	Fixed Time TRANSYT		8 - 16%	6 - 25%	
Sweden/Uppsala AUT/2000	Fixed Time TRANSYT				NO_x reduced by 16%
CHINA/Beijing SCOOT/1989	Isolated FT	2 - 17%	15 - 41%	15 - 33%	
CHINA/Shanghai SCATS/1986	Isolated FT	10%	25%	12%	

There are benefits and disbenefits to the different types of ATC systems for cities in developing countries. Such cities typically experience rapid growth in motorized traffic, lack road infrastructure, have under-developed traffic management and ITS, and lack expertise in basic traffic management techniques. Some of the challenges for instituting ATC in developing cities include particular differences between fixed-time systems and traffic-responsive systems. In general, the "in-between" systems of partially responsive plan selection and generation, as well as local adaptive systems, suffer the disadvantages of both fixed-time systems (where plans must be calculated and updated) and traffic-responsive systems (where detection and central control is required) without providing significant advantages. Table 7.4 summarizes this issue.

The problem of a piecemeal approach. Developing cities tend to adopt a piecemeal approach to traffic signals and ATC development as funds permit. They often implement single junctions or signals at major junctions within a network, leaving intermediate junctions unsignalized. This approach may not result in significant benefits if adjacent junctions remain unsignalized. Such a fractured ATC development may respond to traffic congestion at the junctions where it is implemented, but it usually just displaces traffic problems elsewhere. Nevertheless, solutions need to be found to account for this reality.

The problem of legacy systems. Developing cities are often at the mercy of assertive signal companies, eager to get cities to lock-in to their proprietary systems as can be seen in the cases of Hanoi, Vietnam (described in Box 7.1) and Wuhan, China (described in Box 7.2). This can cause future compatibility problems when an ATC is expanded, especially if the expansion is meant to fill gaps within the legacy system rather than deploying in a distinctly new area. Wuhan dealt with legacy systems better than Hanoi by completely replacing old systems rather than trying to integrate disparate systems with different communication protocols, a rarely successful undertaking.

Photo by Babatunde Olajide on unsplash.com

Table 7.4:
ATC for Developing Cities

Benefits of fixed time ATC systems in developing cities	• No requirement for on-street detectors such as induction loops set into the carriageway (which suffer the problems of poor road surfaces and poor maintenance) or other forms of detection such as infra-red, ultra-sonic, video or microwave. • Can be implemented without using a central computer using so-called "cable-less linking" with time clocks in each junction controller; this minimizes disruption and the costs of cabling and communications.
Disbenefits of fixed time ATC systems in developing cities	• Need for technical expertise in electronics, traffic command center management if centralized control used, computing and traffic engineering techniques. • Need for a high level of commitment, expertise, and resources in data collection in order to calculate all the fixed time plans needed to implement the signal timings. • Need to carry out classified junction turning counts. • Need to address the issue of Fixed Time plan ageing whereby the fixed-time plan (calculated on historical data often a year or more old) can quickly become outdated and inappropriate for traffic volumes and patterns. • In developing cities where traffic growth is often rapid and traffic patterns fluctuate, fixed-time systems need a full-time team committed to data collection and plan updating, otherwise the benefits of ATC cannot be realized or maintained.
Advantages of adaptive systems in developing cities	• Signal settings evolve and are continually updated so there is no need for pre-calculated signal plans and the attendant problems of data collection resources and expertise. • A traffic database is inherent in the system and automatically updated and maintained. • Classified junction turning counts are not required as the system detectors use cyclic flow profiles to calculate signal settings. • Can respond to the rapid growth of motorized traffic in developing cities and the fluctuating traffic patterns without the need for manual data collection and new plans to be calculated; there is no Fixed Time (FT) aging plan.
Disadvantages of traffic adaptive systems in developing cities	• As with fixed-time systems, there is a need for a high level of technical expertise in electronics, traffic command center management if centralized control is used, and computing and traffic engineering techniques, but there is less need for data collection expertise and resources. • Need for on-street detectors to be operational and well-maintained. • Need for expensive centralized control.

BOX 7.1: HANOI, VIETNAM: LEGACY ATC

Legacy Systems - Case Study, Hanoi, Vietnam: This example illustrates characteristics of legacy ITS, new ITS, and the problems of integration. In the early 1990s, Hanoi had few traffic signals in various legacy systems. Even when a more comprehensive ATC system was installed in the late 1990s and early 2000s, the issue of integrating the different suppliers remained problematic. The issues continue to this day with various international suppliers vying for contracts as shown in Table 7.5.

Table 7.5:
Hanoi Area Traffic Control (ATC) Timeline

Date	Installed by	Provided by	No. of junctions	System
1990s	ESR	French	4	Isolated Fixed Time
	BOSCH	German	2	Isolated Fixed Time
		Local/imported	5	Isolated Fixed Time
1996 - 1997	SAGEM	French Grant Funds	36	SMART (Adaptive)
1998 - 2000			72	
2002	Japanese	JICA funds	1	Isolated Fixed Time
2004 - 2005	Tyco Singapore	World Bank Project	78	SCATS (Adaptive)
2019	Siemens	Siemens	1	VAST (Adaptive)

In 2021, Hanoi has two incompatible ATC systems, SAGEM and Tyco, that are both poorly maintained and at the end of their respective lives. While it is not uncommon to find two systems operating in the same city, they usually control different geographical areas of the city. In Hanoi, this was not the case, and the systems would have been intermingled and unlikely to be able to operate in a fully adaptive mode. Notwithstanding this situation, evaluation showed that journey time savings of more than 30 percent were achieved on selected project corridors over the baseline case of corridors with no traffic signals at all.[171] Vietnamese internal procedures delayed implementation of both ATC systems. The government made design changes and delayed road opening permits, while the police stopped installation during the daytime to limit disruptions. The late procurement of the signal system prevented coordination with other civil works, and in some cases new footways had to be dug up to install cables and detector loops.

In March 2019, Siemens installed their "sX" traffic signal controller at the Pham Hung – Me Tri junction as a pilot project. This state-of-the-art technology uses the Video Analytics for Smart Traffic (VAST) adaptive system with its above-ground detection technology which avoids the problems of digging up the roadway to install detection loops. The objective is to convince Hanoi authorities to upgrade the deteriorating SAGEM and TYCO systems which are now over 15 years old.[172]

171. World Bank Implementation Completion Report, 2006.

172. https://www.vir.com.vn/siemens-installs-intelligent-road-solutions-for-hanoi-66698.html accessed 19 December 2020.

Photo by Josh Stewart on unsplash.com

BOX 7.2: WUHAN, CHINA: LEGACY ITS

Legacy Systems - Case Study, Wuhan, China. In the early 2010s, an ATC system supplied by the Spanish company SICE in the Hankou District of Wuhan was replaced after 10 years. This system was considered to be a pseudo-adaptive or responsive system. The reasons for its replacement were:

- Difficulties of expanding the old system which was becoming obsolete with difficult-to-replace parts;
- The need to deploy the new system at infill junctions amongst junctions operating on the old system; and
- The rapid advances in technology superseding the capabilities of the legacy system.

It was cheaper to take out the old system and redeploy it at suburban locations than try to integrate it with any new system. Ultimately, equipment for 159 new junctions were procured under a World Bank-funded project in 2016. The ATC was further developed over the years and now Wuhan has two different ATC systems. There is no issue with two different systems because they operate on either side of two rivers, the Yangtse and Han Rivers. The distance between them is more than 500m, so there are no benefits of close coordination due to platoon dispersion. In the early 2000s, Wuhan only had 185 sets of isolated fixed time traffic signals in a city of 11 million; in 2020, it had 1,425 traffic signals. The timeline is shown in Table 7.6.

Table 7.6:
Wuhan Area Traffic Control (ATC) Timeline[174]

Date	Installed by	Provided by	No. of junctions	System	
Pre-2000	Wuhan Traffic Police	Local funds	185	Hankou; Hanyang	None. All signals are isolated FT.
2000	SAINCO	Spanish Grant Funds	16	Zhuan Kou Economic Zone in Hanyang District	Isolated VA. (Note: not SAINCO's ITACA system)
2000s	SICE	Spanish Grant Funds	129	Hankou	PCMOT
2008	SIEMENS	World Bank Loan	426	Wuchang	SCOOT (Adaptive)
2010s	HISENSE	World Bank Loan	159	Hankou (replaces SICE signals)	HICOM (Adaptive)
2020	Wuhan Traffic Police	Local funds	510	All Districts	More junctions added into SCOOT and HICOM systems
	TOTAL		**1425**		

ROADMAP TO ITS

To facilitate the development and deployment of ITS, see Table 7.7 which provides a roadmap and timeframe for strategic, operational and tactical tasks to undertake.

173. The World Bank, Implementation Completion and Results Report, Loan Number 7864-cn on a loan in the amount of US$100 million to the People's Republic of China for a Wuhan Second Urban transport Project, June 28, 2019.

174. Source: Email correspondence between the author and Wuhan Traffic Police, 11 January 2021.

Table 7.7:

A Roadmap of Strategic, Operational and Tactical Tasks for Developing and Deploying ITS

EASI Framework	Intelligent Transport Systems	LEVEL	TIMELINE
IMPROVE	**Utilize a smart city approach by deploying Intelligent Transport Systems (ITS) including crowd-sourced smartphone applications and making use of the latecomer advantage to leapfrog to the latest technology to IMPROVE traffic management and give it high status.**		
1. Learn from local and international experience relevant to Sub-Saharan African cities.	• Trends in smart cities. • Trends in smart mobility with the Chinese case is particularly relevant; Chinese cities have been rapidly transformed over the past 20 years through ITS: Chinese technology is making inroads into Sub-Saharan Africa.	STRATEGIC	SHORT TERM
2. Develop a regulatory and institutional framework for ITS.	• Capitalize on "latecomer advantages." • Deploy the benefits of user-centric, data-driven and "bottom-up" innovations; utilize the benefits of Big Data, especially crowd-sourced from individual smartphones. • Promulgate laws and regulations governing the use of personal data to ensure data privacy while enabling appropriate utilization of anonymized data.	TACTICAL	SHORT TERM
3. Install "bottom-up" ITS focusing on traffic signals, ATC, and crowd-sourced apps for Mobility as a Service.	**For traffic signals and ATC:** • Start off with sets of isolated traffic signals at selected junctions with simple phasing such as two-phase north/south and east/west movements. • Complement these traffic signals with the "Three Es": physical junction channelization engineering, education for road users, and enforcement of the traffic signal phasing. • Expand the isolated traffic signals to more junctions. • Experiment with more complex phasing whereby "green man" pedestrian phases can be signaled and where conflicting turns can be separately signaled in "late start" or "early cut-off" techniques. • Start to coordinate isolated signals where they are less than 500m apart. For longer distances, there can be little benefit in coordination due to platoon dispersion. Coordination can be done on a fixed time basis through timeclocks, for example. • Ensure that the traffic police are trained in the traffic signal capability so that they do not conflict with the phasing or switch off the signals. • Expand coordination into a small fixed time ATC system using the existing technologies in the traffic signal controllers. • Invest in further technology such as a fiber-optic communication network. This can be above ground if necessary. • Develop a Traffic Command Center (TCC) and expand the functions of ATC to include traffic monitoring cameras and electronic police enforcement cameras. • Consider utilizing detection methods, such as above ground detection, to coordinate the signals in a traffic adaptive mode. • Take care to minimize issues related to legacy ITS systems and be wary of assertive ITS vendors with proprietary systems. **For Mobility as a Service:** Further develop crowd-sourced transport and navigation apps to promote PT and paratransit systems.	OPERATIONAL	SHORT TERM

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CONCLUSIONS

Traffic management measures are proven to have a tremendous impact on achieving the livability, competitiveness and inclusion objectives of cities worldwide. They are often considered low-cost and easy-to-implement when compared to other transport interventions such as road widening and construction. Traffic management techniques and measures are embedded in all road transport infrastructure, including Public Transport (PT) operations, road safety, and Intelligent Transport Systems (ITS). Traffic management is an essential complement to the safe and efficient operation of road networks. Good traffic management must provide for all road users, especially pedestrians and Non-Motorized Transport (NMT) modes, based on people-centric and safe system approaches.

However, there are very limited success stories involving comprehensive implementations of traffic management measures in Sub-Saharan Africa. Research and observations in the Africa region indicate that, as of early 2021, most traffic management interventions have entailed piecemeal approaches rather than comprehensive ones. There are a myriad of projects and studies with laudable aims and excellent recommendations, but it is regrettable that extraordinarily little has been successfully implemented and sustained. The reasons behind the limited success thus far include the institutional fragmentation, operational complexities, monitoring and enforcement difficulties, and lack of broader technical expertise in traffic management plaguing most cities. Still, Sub-Saharan African cities can exploit the potential of traffic management to better use existing infrastructure and manage demand, with the ultimate objective of making cities more livable and competitive.

Based on the EASI framework, this report identified five themes in traffic management in Sub-Saharan cities where there is room for improvement: institutional development; development of a Functional Road Hierarchy; pedestrian measures; parking management; and ITS. The report presents good practices from developed and developing countries and provides roadmaps and timelines as guides for implementation. The recommendations combine top-down and bottom-up approaches. The top-down approach helps ensure long-term sustainability, through improvements in the institutional arrangements for traffic management and the road hierarchy. Meanwhile, the bottom-up approach helps showcase the potential and results of implementing better traffic management practices. This bottom-up approach consists of kickstarting implementation with small-scale traffic management measures, measuring results, and scaling-up interventions using an iterative process.

Finally, as with any innovative approach that challenges the status quo, traffic management needs a champion, whether it be a city mayor, a local government official, or an ordinary citizen. Traffic management also requires adequate funding, whether it be from local governments in the Sub-Saharan Africa region or other entities at the national and international levels.


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