Khartoum Urban
Transportation Upgrade
1.0 Background

Across the world, inadequate infrastructure presents major economic and social challenges that governments and businesses need to address. Without the necessary infrastructure—from transport systems to electricity grids and water pipelines—economies cannot meet their full growth potential and economic and human development.

The priority to invest more in infrastructure comes at a time when many African governments are highly indebted and face competing calls on their scarce resources.

Improving the planning, delivery, and operation of infrastructure to get more, higher-quality capacity for less money and a boost in infrastructure productivity should be a priority amongst planners.

In this report K.I.S Consultancy examined a range of global databases as well as national sources that report both public and private spending on infrastructure. With the exception of a few national sources for transportation data, we used International Transport Forum (ITF) data for road, rail, port, and airport spending; IHS Global Insight for power and telecommunications spending; and Global Water Intelligence (GWI) for spending on water and sanitation. These were the most comprehensive sources available.

2.0 Importance of Infrastructure

Infrastructure spending drives economic growth, creates jobs, and delivers vital services, such as a clean water supply and transportation links. The World Economic Forum estimates that every dollar spent on a capital project (in utilities, energy, transport, waste management, flood defence, telecommunications) generates an economic return of between 5% and 25%. That multiplier effect accounts for the rapid economic growth of emerging markets that have made infrastructure spending a priority.

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World Economic Forum

Public infrastructure projects can cost significantly and tend to require the assistance of international banks and donors. With financial risks and benefits associated with large scale
infrastructure development – government decision makers and planners need to identify the best way to address the economic capability gap caused by a lack of infrastructure.

Infrastructure is a cornerstone of a stable and productive society. The right approach to delivering and maintaining transport, housing, energy, water and communication infrastructure is essential to create a strong and competitive economy and provide social services. Infrastructure projects also offer opportunity for both the public and private sectors.
3.0 Urban Transport Networks

Urban transport networks and urban growth Urban transport, a multi-faceted activity, dictates the quality of life of millions of the urban dwellers, whether they are residents of developed or developing cities. The transport system plays a key role in cities’ development and their future growth taking into account the many new extensions that are established on major transportation lines. Thus, the transportation plan is an integral part of land use plans and land use is the major driver of traffic generation. Inadequacy of public transport systems leads to limited mobility and disables the function of the impacted parts of the city, particularly when the transport fleet is unable to transport workers within the desired working hours. Public transport also facilitates unity and fusion of city parts by enhancing the social communication process between all layers of the urban society.

High Speed transport links in developed nations brought about by a will to increase productivity of transport systems.

Developing nations are still in transition stage between regular road building that feeds into city centres and urbanised congested zones and faster more efficient transport systems.
Khartoum city depends on a single-modal transport – vehicular road system. Mass transport modes are completely absent making Khartoum unable to meet citizens’ mobility demand. Thus passengers facing long time delays in transport stations. Slow traffic speeds and severe traffic jams result in long trip periods, high traffic accidents rates and high suspended particulate concentrations accumulating in the air. This situation is attributed to:

- Use of small-sized vehicles running on limited paved road network.
- Adoption of extensive grid iron planning patterns lacking multi-grade intersections.
- Eroded public transport fleet and extremely overcrowded urban centres.

Negligence of public transport systems integration into landuse plans and urban structure restructuring difficulty crippled public transport revitalisation for no space is left for mass transport infrastructure construction. Moreover, transport systems’ operation mismanagement and focus on economic development increased pressure on transport systems.
3.1 Urban Connectivity in Khartoum

To revitalize urban transport, Khartoum main transport infrastructures must be efficiently operated by establishment of an able transport authority supported by strong legislations and popular authorization.

In a study carried out by Dr Bannaga, former Minister of Infrastructure and Transport, Khartoum, primary data was gathered through a number of household and field surveys conducted as part of a number of urban studies tackling Khartoum's rapid urbanisation.

In the mentioned studies, information was gathered from a number of sources:

- Questionnaires were used to collect information from the urban and rural households in Greater Khartoum.
- Road side's *field* surveys were conducted manually by counters employed by the designated consultants to count vehicles on streets, number of daily passengers, vehicles number and type, origin and destination of the journey and its type and duration.
- Interviews targeting concerned officials and the public were conducted in person to know their perspectives and opinions.
- Data from Khartoum State ministries and competent departments were compiled.
- Observations for seeking additional information on passengers on board and vehicle drivers’ behaviours and conducts were recorded.

In order to meet the current and future traffic demands the following actions should take place:

- Rehabilitating and expanding the existing infrastructures.
- Deploying large-capacity multimodal transport systems including river transport, bus rapid transit systems, tramways and metropolitan railways to connect Khartoum polycentric and its sprawling outward growth.
- Mitigating environmental pollution and enforcing stringent road safety measures.
- Reviewing traffic laws to tighten traffic regulations and control traffic flows.
Data received from respondents’ responses and field surveys were structured and analyzed to identify the current status of the public transport systems and to judge whether they are adequate and efficient to ease residents’ mobility through Khartoum Metropolis and its peripheries.

The data was also used to identify the impacts of public transport on the urban environment and to formulate present and future plans for revitalizing the transportation systems.

From this study we can attempt to:

- Quantify and present Khartoum’s needs for increased public transport systems considering Greater Khartoum rapid urbanization.
- Evaluate the current status of Greater Khartoum urban transport, make an assessment and propose the projects that are required to be implemented to address the growing urban problems in public transport.

### 4.0 Destination of population movements

The studies have shown that the primary function of the public transport service lines provide transport links between homes and the workplace while the other connect the institutions of learning.

From the questionnaire, results shown in Figure 1, commuter who were asked about their destinations:

- 50% said going home,
- 28% were going to work and
- 16.7% were school students heading for schools and universities.

Other trips are for social gatherings, shopping and recreation.
4.1 Destination and Frequency of Population Movements

It is estimated Khartoum traffic need in 2015 as more than 4 million passengers’ trips per day, of which 2,865,080 trips are required to be covered by public vehicles as provided in Table 1. The percentage of passengers using public transport compared to private transport was 70%.

In comparison, the number of passengers using public transport and travelling throughout Greater Khartoum in 2005 was far less than the 2015 figure (42%) as exhibited in Table 2. This is of course obvious because of the rapid population growth.

Table 3 shows the estimated number of vehicle trips heading towards the main centres of Khartoum, Khartoum Bahri and Omdurman and the number of passengers moving during an average day in 2015. It indicates that one and a quarter million (1,246,250) passengers per day move towards the main urban centers and this number represents more than 43% of the total number of passengers travelling using public vehicles.
4.2 Khartoum Mobility Data

**Table 1:** The number of daily passengers’ trips in the designated year

<table>
<thead>
<tr>
<th>Year</th>
<th>Passenger Trips in a Day</th>
<th>Passenger Trips in a Day using public Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3,087,524</td>
<td>2,161,267</td>
</tr>
<tr>
<td>2015</td>
<td>4,092,297</td>
<td>2,865,080</td>
</tr>
<tr>
<td>2025</td>
<td>5,425,840</td>
<td>3,798,088</td>
</tr>
<tr>
<td>2035</td>
<td>9,562,137</td>
<td>6,693,496</td>
</tr>
</tbody>
</table>

**Table 2:** Public vehicles and numbers of passengers in Khartoum state/day in 2005

<table>
<thead>
<tr>
<th>Type</th>
<th>Licensed</th>
<th>No. of Trips</th>
<th>No. of passengers/trip</th>
<th>Total No. Of passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil buses</td>
<td>69</td>
<td>8</td>
<td>50</td>
<td>27,600</td>
</tr>
<tr>
<td>Tourist buses</td>
<td>89</td>
<td>8</td>
<td>50</td>
<td>35,600</td>
</tr>
<tr>
<td>Mini-buses</td>
<td>7705</td>
<td>8</td>
<td>25</td>
<td>1,541,000</td>
</tr>
<tr>
<td>Taxi</td>
<td>96</td>
<td>8</td>
<td>7</td>
<td>5,376</td>
</tr>
<tr>
<td>Medium</td>
<td>2203</td>
<td>7</td>
<td>7</td>
<td>107,947</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>171,523</td>
</tr>
</tbody>
</table>

**Table 3:** Number of passengers Travelling per Day in 2015 to Khartoum, Khartoum Bahri and Omdurman Centres.

<table>
<thead>
<tr>
<th>Region</th>
<th>Bus (25 passengers) On average</th>
<th>Number of trips per Bus per Day</th>
<th>Total Number of Buses</th>
<th>Number of Passengers Travelling per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khartoum</td>
<td>3,337</td>
<td>409</td>
<td>38,382</td>
<td>959,550</td>
</tr>
<tr>
<td>Bahri</td>
<td>392</td>
<td>67</td>
<td>3,398</td>
<td>84,950</td>
</tr>
<tr>
<td>Omdurman</td>
<td>759</td>
<td>92</td>
<td>6,006</td>
<td>201,750</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>1,246,250</td>
</tr>
</tbody>
</table>
4.3 Road transportation is the only form of Transportation

The public transport system in Greater Khartoum does not use all means of transportation but relies on one mode system which is road transport depending on vehicle operation. Systems such as river transport, railways and metros are not in use. The system is increasingly dependent on small vehicles despite the fact that transportation by means of vehicles running on roads is easy and fast, especially in remote subdivisions, which are difficult to access by other means. On the other hand, dependency on vehicle transport requires extension of roads and construction of multi-grade crossings to ensure smooth traffic flows.

4.4 Roads and Bridges Improvements

It was observed that efforts during 1970s to 1990s towards achieving minimum goals in the transport sector were much less but some progress was made by the State in the early nineties and at the beginning of this century when the road networks started to expand and in the middle of 2010 and large funds were allocated, which led to the expansion of road networks and increase of the number of bridges. In spite of these efforts the transport system is still operating at low efficiency. This is because intensification of economic developmental activities in Khartoum is placing an increasing pressure on the road network.

Currently the installed network of asphalt roads covers 1,723 kilometers which are spread across the central regions of the three main cities. This falls short of serving the remaining vast area dominated by a grid-iron layout pattern as indicated in Figure 4.

Figure 2 – Paved Roads - Khartoum
The newly executed Nile bridges and the flyover crossings constructed over selected road intersections are shown on Figure 3. These limited multi-grade intersections and Nile bridges were constructed by the present government to facilitate traffic across the main roads and over the Nile rivers and they eased traffic flows tremendously.

Figure 3 – Bridges built across Khartoum to ease transport flow

It is to be emphasized that continuous rehabilitation of the road network is required and there is a strong need for institutional strengthening and personnel training to go along with the development of the road networks. Without training and capacity building, urban transport is expected to be a major obstacle to Khartoum’s growth.
4.5 Types of Vehicles used in Khartoum

Table 4 – Number and type of vehicles in Khartoum

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Cars</td>
<td>142,019</td>
<td>161,817</td>
<td>171,700</td>
</tr>
<tr>
<td>Mini Bus</td>
<td>20,925</td>
<td>18,920</td>
<td>15,799</td>
</tr>
<tr>
<td>Large Bus</td>
<td>608</td>
<td>499</td>
<td>495</td>
</tr>
<tr>
<td>Taxi</td>
<td>2,988</td>
<td>2,216</td>
<td>1,294</td>
</tr>
<tr>
<td>Freight Transport</td>
<td>4,460</td>
<td>4,470</td>
<td>4,849</td>
</tr>
<tr>
<td>Lorry &amp; Trucks</td>
<td>6,736</td>
<td>8,922</td>
<td>9,752</td>
</tr>
<tr>
<td>Motor Cycle</td>
<td>532</td>
<td>670</td>
<td>852</td>
</tr>
<tr>
<td>Investment Vehicles</td>
<td>7,062</td>
<td>8,588</td>
<td>8,147</td>
</tr>
<tr>
<td>Rucksha</td>
<td></td>
<td></td>
<td>3,603</td>
</tr>
<tr>
<td>Government buses and</td>
<td></td>
<td></td>
<td>8,800</td>
</tr>
<tr>
<td>vehicles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>185,578</td>
<td>206,647</td>
<td>225,892</td>
</tr>
</tbody>
</table>

This data was collected in 2011, the registered vehicles number in 2011 includes 171,700 as private cars and only 15,799 as mini-buses as exhibited in Table 5. There have been an increased in the population of Khartoum, approximately 8% on year average. Other changes that have occurred are the occurrence of car sharing services such as Terhal which is a share sharing service, similar to UBER that lets drivers in the city pick and drop of passengers efficiently with less downtime and hence unnecessary traffic build up of taxi’s and amjaats vehicles.

It is noticeable that private cars are increasing significantly in Khartoum, though cars ownership rate in developed countries is more than 20 times than in Sudan. Recently, in the a study conducted by the author, it was noticed that 47.6% of users use different types of buses followed by 20.7% using private cars which is a large proportion. In (MEFIT 2014) study, it was noticed that about 11% of the respondents own a car.
5.0 Use of Fuel in the Urban Transport

Khartoum consumes fuel intensively where petroleum products are supplied for various energy consumption sectors particularly in urban transport which is the most important in modern urbanization. The transport sector is the largest consumer of oil in Khartoum, it consumes 66.5% out of 3 million (TOE) which are consumed by Khartoum annually.

5.1 Bus stations/terminals and bus stops

Bus Stations/terminals are important elements in the operation of bus systems. Some of the stations are more important in terms of the provided public and local bus services. The main station often provides such services as well as providing the type of business that a passenger needs.

At major transport stations Khartoum is almost suffocating from queues of stranded passengers waiting for seats in buses in the dark and peak hours. The intermediate stations are adjacent to municipalities’ main markets. Khartoum State ignores bus stops where loading and unloading of passengers occur near their homes. Recently, Khartoum signed an agreement with DAL Group to finance and install 1000 bus stops shelters along the transportation lines. The bus stops are to be equipped with the necessary facilities in return for advertising the company’s products.
5.2 Urban transport institutional framework

Some cities have the means to operate public transport and in others, the private sector undertakes almost all transportation activities while only governments construct and maintain public transport infrastructures. There are cities that operate public transport systems on the basis of partnership between private and public sectors. In Khartoum, a number of traffic management models were tried during different government rules. The current State Government merged Petroleum Department with Public Transport Department. The Directorate of Public Transport and Petroleum was then established to manage the three provinces’ local offices: Khartoum, Khartoum Bahri, and Omdurman. After the establishment of the new provinces -Jabal Auwlia, Karari, (East Nile) and Umbadda urban transport has been managed by the transport departments established in the seven provinces operating under the umbrella of Khartoum State General Administration of Transport and Petroleum, Ministry of Finance and Economy. Recently, the Ministry of Infrastructure has replaced the Ministry of Finance and became responsible for managing public transport and the direct responsibility is given to Roads and Bridges Corporation. This order is in conformity with the Ministry of Infrastructure functions and responsibilities stated in the Local Government Law of 2001.

5.3 Assessing the present conditions of public transport systems in Khartoum

5.3.1 Assessment Criteria

At present Khartoum Transport system is under capacity and does not meet the following requirements:

- Covering all parts of Greater Khartoum and operating multi-modal transport system giving various options.
- Quantify current infrastructure assets and evaluated expansions and renewals
- Reliable, of large system capacities, supported by adequate transport infrastructures and fleet and operating efficiently while applying modern technologies in all practices.
- Environmentally safe, socially adequate, using sustainable energy technologies, maintaining safety measures and easily accessed and free from traffic congestion and accidence.
5.3.2 Incomplete Urban Planning

Local planners ignore the transportation requirements in landuse plans despite the fact that layout plans of road networks are integral part of any landuse or base maps. There is no clear classification pattern of the existing road network i.e. neither having an order of sequence nor road hierarchy. Landuse is the most influential factor directing traffic and people mobility. Negligence of incorporating the transportation lines into structural plans has resulted in:

- Lack of space for installing large-capacity transport systems infrastructure as well as for construction of new bridges and flyovers over road intersections considering that land acquisition is now terribly expensive.
- Adoption of less than normal population density and this increases the lengths of the transportation lines.
- Existence of physical barriers obstructing traffic.
- Lack of adequate parking spaces and this compels motorists to park their cars on roads’ edges thus, reducing roads’ widths. In addition, vendors occupy the sidewalks and road shoulders thus, obstructing motor and people movement.
- Difficulty in finding outlets to expand the Khartoum Center activities due to concentration of government institutions that are becoming obstacles to spatial reorganization and traffic restructuring.
5.3.3 Use of small capacity vehicles

The capacity of public transport vehicles is inadequate and people suffering from a low speed traffic flow. For a long time, Khartoum relies on small and minibuses and vehicles operating intermittently. It is known that most developed and some developing cities are using trains. Western cities use trains running under and above ground. Budapest, Moscow, Paris, New York and London are among the most recognized cities using subway lines. The use of trains for urban transport maintains the cleanliness of the environment and solves the problems of traffic jams while reducing the incidence of disease and accidents.

5.3.4 Inadequacy of transportation infrastructure

Greater Khartoum is currently experiencing a high demand for public mobility and this is not met by the transportation system for road networks do not cover the entire urban mass and the transporting capacity is insufficient and vehicles run with very low traffic speeds.

In addition, paved roads are limited and a terrible need exists for construction of multi-grade intersections in locations to convey direct movement and to cross Nile Rivers. Now passengers are forced to stay in vehicles for a long time before reaching their destinations.
The bus stations and terminals are neglected although they are important elements of public transport systems, as they provide passengers’ access to transport vehicles. They are not integrated into public transport systems; instead hundreds of buses stay off roads on unprepared or temporary stations and on vacant areas in metropolis centres.

There is neither an interest in traffic route planning nor in installing street signs of all kinds including light signals. These are required to be intensified, protected and monitored frequently. It is known that the signals are the primary responsibility of traffic management because they organize traffic and they are vital in achieving safe and efficient traffic flows.

**Figure 5** – Location of Points of Traffic Jams and congestion
Figure 6 – Location of Traffic Jams during working hours
6.0 Use of Khartoum’s existing Infrastructure Assets

Building new infrastructure can be an expensive and long winded process if current demands are not assessed and quantified. The construction cost of building an underpass within the city, for example, would cause operational down time of the nearby roads and detouring, in addition to construction costs materials and logistics, can often make new projects within the city unattractive to consider economically and socially.

The first step to consider for local actors would be to quantify the infrastructure assets under the public domain, and find ways how to expand on them whilst causing minimal disruption to the current transport network and keeping it low cost.

Quantifying the infrastructure assets that are public and privately owned such as public roads, highways, transit, universities, hospitals, schools and other see Figure 7 for complete list. Can enable transport authorities to link the members and gain collective support and collaboration for major projects.

Future research the Ministry of Infrastructure and Transport is planning to undertake in co-operation with other ministries and outside experts to improve evidence-based decision-making for infrastructure investments. This includes developing research to better understand what infrastructure Khartoum currently has in place and the capacity of that infrastructure to deliver services. It also includes gaining a better understanding of current and projected demand for services delivered by that infrastructure, which would in turn allow for a determination of current and future utilization levels. Having an understanding of capacity, demand and utilization would ultimately help to inform a strategy on how to meet Kharotoums infrastructure needs, based on the gap between capacity and demand.

The strategy to close that gap could involve, among other actions, investing in new capacity, getting more out of existing capacity by using capacity more efficiently or managing demand.
Figure 7 – Khartoum’s Capital Assets, Distribution of Ownership

**Provincially Owned Assets**

**Provincially Owned Facilities**
- Government Owned
- Government Agency Owned
- Government Business Enterprises (e.g. LCBO, OLG)

**Transportation Infrastructure**
- Provincial Highways & Bridges

**Other Capital Assets**
- Capital Improvements in Owned & Leased Buildings

**Assets Owned by Broader Public Sector Partners**

**Broader Public Sector Organizations**
- Hospitals
- Schools
- Colleges

**Other Transfer Payment Partners**
- Universities
- Social Service Facilities
- Long-Term Care Facilities

**Municipal Governments**
- Municipal Roads & Bridges
- Municipal Culture & Recreation Facilities
- Municipal Transit
- Municipal Water & Wastewater
- Social Housing
- Other Assets
6.1 Use of Existing Infrastructure Assets

Figure 8 – Better organisation of road
6.2 Organising Khartoum’s current road infrastructure

While street performance is conventionally measured based on vehicle traffic throughput and speed, measuring the number of people moved on a street — its person throughput and capacity — presents a more complete picture of how a city’s residents and visitors get around. Whether making daily commutes or discretionary trips, city residents will choose the mode that is reliable, convenient, and comfortable.

Transit has the highest capacity for moving people in a constrained space. Where a single travel lane of private vehicle traffic on an urban street might move 600 to 1,600 people per hour (assuming one to two passengers per vehicle and 600 to 800 vehicles per hour), a dedicated bus lane can carry up to 8,000 passengers per hour. A transit way lane can serve up to 25,000 people per hour per travel direction, something that can breathe life into the city of Khartoum.
6.3 Revitalizing public transport systems in Khartoum

6.3.1 Establishing a public transport authority in Khartoum

It is well known that city management is not difficult because it is supported by enormous economic and human resources. Khartoum has enormous potentials as multiple natural resources and if these potentials are sourced it will succeed in revitalizing its urban networking. What is needed is that Khartoum state sets up a public transport authority authorized to attract investors to revitalize public transport systems using advanced technology and sound management of resources. The first task that Khartoum State undertakes is appointing a new and effective administration, supported by state legislations and popular mandate and able to pursue an integrated approach e.g. adopting decentralization and applying democratic mechanism to ensure popular participation in decision-making without creating conflicts between local institutions. The Authority shall immediately undertake:

- Building the system institutional capacity by strengthening public transport institutions and raising professional competence.

- Preparing and implementing a comprehensive transportation plan (a number of studies are available for the preparation of this plan) based on operating multiple intermodal systems. The plan shall delineate all components of the transportation infrastructures and their phases of construction: road networks, tracks used by Transit Bus System, river transport lines, bus stations, rail and tram tracks, river bridges, multi-grade intersections on road crossings, etc.
Reactive: Struggling to keep pace with demand, and less attractive city in which to live, work, and do business.

Survival
Minimal urban infrastructure to meet basic human survival needs such as running water and shelter.

Basic
Infrastructure to ensure more basic needs are met in terms of healthcare, primary and secondary education, transport connectivity within a city and to surrounding areas, and access to power for households and business.

Advanced
Infrastructure geared more toward improving economic growth and productivity, competitiveness, and economic efficiency, including mass transit, commercial property, technology, global connectivity, advanced university education and research, and enhanced natural-disaster risk management, such as flood defenses, to prevent human suffering.

Quality of life
Infrastructure targeting more advanced human needs to improve all aspects of quality of life and sustainability, including elderly care, green space, leisure and cultural assets, and environmental infrastructure.

Source: PwC, Cities of Opportunity: Building the Future
6.3.2 Performing the necessary urban transformations and changes

No doubt that restructuring of the urban structure for accommodating transportation infrastructures and performing changes in urban activities and functions have a significant impact on enhancing urban transport networks. Restructuring of the urban structure is needed to improve the efficiency of public transport and ease traffic movement. However, it is known that restructuring may lead to the demolition and removal of many buildings and abandonment of many activities.

6.3.3 Implementing a comprehensive development programme

The programme shall include the followings:

1. Expansion of existing transportation lines to meet current and future traffic demands.
2. Constructing new roads, bridges and express ways to upgrade the transportation networks and to carry traffic flows away from the CBDs, without resorting to crossing the central areas of Greater Khartoum.
3. Constructing ring roads to link regional transportation lines and suburban centers.
4. Constructing varied Infrastructures to pave the way for operation of mass transport systems.

It is meaningful to begin with river transport because it capitalizes on Greater Khartoum location characteristics. Khartoum is endowed with three Nile Rivers forming water arteries suitable for river transport. These rivers dictate traffic paths, influence urban development and expansions. Furthermore, river transport is economically feasible, safer and causes less accidents and environmental pollution. It does not need construction of roads or bridges or expropriation of land. It is fuel efficient because its transport capacity is greater and consumes far less fuels. Therefore Khartoum State should immediately put in place a river transport infrastructure; reclaim waterways, clean the navigable lines, place navigational signs, construct river and marine stations and side steps. River transport development is not difficult because funding can be made availed by the private sector if encouraged to do the job.

“The true sign of a civilized society is how it cares for its most vulnerable and prepares for the worst, and how it addresses the most fundamental of human needs like having good shelter.”
The daily movement of people bordering the Nile Rivers is sufficient to provide market for the river transport system knowing that the main destinations for passengers are adjacent to the rivers. A study conducted by the author revealed that a proposed river transport project cost can be returned within (8) years.

The second mode of transport that can be implemented is the Rapid Bus Transit System (RBTS) running at high speed but this system necessitates construction of new roads and expansion of some other roads which function is to ease the free movement of the rapid buses without crippling the system by road intersections. Rapid Bus Transit systems provide net positive benefits to society and are socially profitable investments. Trends at the local, national and international levels suggest their continued growth worldwide. In a report by the Transport and Energy Unit, WSIB, Global Division, UN-HABITAT, (Candiracci 2006) stated that BRT systems reduce: traveling times by 50%, noise and gas emissions by 40% and accidents rates by 90% in the corridors. Later in 2013 UN-HABITAT stated that the costs of BRT systems are one third to one fifth of those of alternative rail technologies.

The third mode of transport that can be implemented is the Light Rail Transit System (LRTS) or tram, powered by electricity but this system requires installation of rail lines (light rail lines) to pave the way for the tram to run through the urban area. The backbone of the LRTS depends on the design and construction of the light rails in addition to traffic signals and tram stations. The LRTS runs along road network and therefore proper planning requires the integration of the other modes of transport with the LRTS.

Operation of railway lines should be based on the existing lines and their expansion can be considered but as a last option. This option requires delineation of rail tracks and train stations at selected routes and sites as well as land acquisition where rail tracks, bridges and train stations would be built. The railway lines will connect rural/suburban and regional areas thus, serving many villages and small towns as well as linking Khartoum with Sudan Railways. More details are found in (MEFIT 2014) report on Structural Plan for Traffic and Mobility.
6.4 Cost of Public Transport

One of the challenges of investing in good public transport is how to ensure that it remains affordable for use for the general public.

The cost of a bus ticket or a future train ticket would be decided based on the local average hourly wage to determine the amount of time a citizen needs to work to buy a rail ticket from the city’s boundary to its central business district.

Local travel patterns and discounts could create different affordability outcomes for any of our cities.

When investing in public services such as a Light Rail Tram Line reduction of traffic congestion and ease of commute are the main purchasing power of citizens when considering which type of transport to pay for. All issues of urban mobility and city transport should be assessed with local business and government leaders to identify business location, investment and transit coverage.

<table>
<thead>
<tr>
<th>City</th>
<th>Mass transit coverage</th>
<th>Affordability of public transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Dubai</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Stockholm</td>
<td>28</td>
<td>5</td>
</tr>
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Figure 9 – Urban mobility data, top transit coverage at affordable price. Source: Pwc – Cities of Opportunities
6.5 Enhancing efficiency of public transport operation

The urban transport authority must resort to advanced operating systems having modern technologies and applications that enhance transportation operation processes, reduce congestion and traffic accidents as well as reducing pollution and energy consumption. Use of communication technologies and devices managed by computer (robot) and electronics enables the transport management to obtain information on the performance of all public and private transport utilities. The other requirements related to efficiency of public transport operation, environmental protection and traffic safety can be met through:

- Public awareness promotion.
- Media intensification for spreading traffic regulations and traffic ethics among residents.
- Deployment of traffic police to enforce road safety regulations.
- Review of traffic laws to tighten the control and monitor traffic flow and protect pedestrians.

Furthermore, the followings shall be considered to mitigate environmental pollution and degradation:

- Hindering use of small-capacity vehicles.
- Imposing use of unleaded gasoline and applying catalytic converter to convert automotive exhausts producing harmful gases to other less harmful substances.
7.0 Conclusion

Sudan’s infrastructure, in particular the city of Khartoum is undergoing a major transformation to build the required capabilities. A review of Khartoum’s infrastructure and the plans and policies related to the operation and growth of that infrastructure should be carried out to provide direction and structure for new projects and ensure consistency with current and future developments.

An up-to-date audit of Khartoum current infrastructure assets should be made in tangent with the demand for new roads, transit routes and other non-vehicular options.

The effective planning, delivery and operation of infrastructure requires people with the right skills and capabilities at each step in the value chain: urban planners to conduct feasibility assessments and manage stakeholder involvement; financial and technical analysts to create cost-benefit analyses; engineers to scope and design projects; project managers to oversee engineering procurement and construction; lawyers to manage contracting; and bankers to advise on financing.

Best in class engineering consultants are required to design and procure simple and sustainable solutions in which local content can be used from planning stage through to implementation and construction; a feature that will increase employment rates and involve the skills of a younger generation to come.
References


2. Bannaga, S and Hassan, A. 2016. Use of River Transport to Enhance Public Transport in Khartoum State. The Arab Engineers’ Union Prize Winning Project, Arab Engineers Union Conference held in Manama, Bahrain, 31 March 2016 (in Arabic version), Arab Engineers Union, Cairo.


KHARTOUM URBAN TRANSPORTATION UPGRADE