

# COMPARATIVE ANALYSIS OF PUBLIC TRANSPORT SYSTEMS IN AFRICAN CITIES

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## ABSTRACT

This paper discusses the application of an assessment methodology on three African cities; Cape Town, Nairobi and Dar es Salaam. The purpose of the methodology is to do a comprehensive study on the performance of public transport systems in these cities. The methodology is used to describe, discuss and evaluate the public transport systems.

A set of components and characteristics are needed to describe a public transport system of a city. The public transport goals and objectives of the cities are used to create a set of key performance indicators that will be used to evaluate and compare the public transport systems of the cities. The evaluation and comparison of the key performance indicators of public transport systems makes it possible to find realistic values for public transport objectives and to also build a database of the performance results. These results can be compared across different years to evaluate whether there has been any improvement in performance and if the strategies implemented are achieving the expected results.

In this paper, the characteristics of the public transport systems of Cape Town, Nairobi and Dar es Salaam are described in detail as well as the evaluation of the performance of the public transport systems for all three cities. The results from the assessment on the three cities are compared across each other to give a clear overview of the public transport systems of the case cities.

The aim of this paper is to present the results from the application of the assessment methodology on the three case cities. The results will represent the current status quo and qualities of the public transport systems of the case cities.

## 1. INTRODUCTION

During the past few decades developing countries have experienced huge population growth. The increase in population has led to the increase in the demand for urban transport, especially in African cities, but the transport infrastructure in these cities is not appropriate for the current transport demand. This has caused serious road congestion and public transport systems are overloaded. Most governments have a lack of financial and human resources to meet these demands. There is a shortage of public transport supply which has led to the emergence and growth of informal transport (paratransit) (Gwilliam, 2002). Paratransit operators have filled the gap between the demand for public transport, and the decreasing supply and level of service of formal public transport services. Informal public transport dominates most of the public transport markets in developing countries (Armstrong-Wright, 1993; Gwilliam, 2002)

From the discussion above it is clear that public transport in developing countries needs urgent attention in order to improve the services provided and to satisfy growing demand.

A lack of adequate information and planning frameworks to guide decision makers has led to the unplanned or poorly planned public transport found in Africa today. Political decision-makers and the regulatory stakeholders involved in public transport have to take the responsibility to ensure that the systems of their country meet the needs of the communities they serve and they also need to ensure that they establish public transport systems that they can sustain with the resources available. Each country and city has different public transport goals and objectives and the public transport system of each city needs to be designed and evaluated in relation to the context of the city and resources available. Performance indicators would give a clearer overview of the systems of cities and make it possible to compare the systems of different cities. There is therefore a need to develop a methodology to assess transport systems in African cities.

The purpose of this paper is to discuss the application of an assessment methodology on three African cities; Cape Town, Nairobi and Dar es Salaam, and to present the results from the application of the assessment methodology on the three case cities. The results will represent the current status quo and qualities of the public transport systems of the case cities. The assessment methodology includes steps to describe, discuss, evaluate and compare the public transport systems of cities. An assessment of quality of performance in terms of the prevailing conditions and the objectives of the country and the city will be useful to identify the public transport issues which the regulatory stakeholders and public transport operators should attend to. It will also give context to the desired performance levels to make them appropriate to the city and country rather than simply adopting them from other cities and countries where different conditions exist. This paper builds on the SATC 2011 paper which discussed the assessment methodology that was developed to evaluate the performance of public transport systems.

## **2. RESEARCH METHODOLOGY**

The research methodology used five phases. The first phase was a literature review to determine the characteristics and performance measures of urban public transport systems. These characteristics and performance measures were used to describe, discuss and compare the public transport systems of the case cities. The literature review was also used as a source to identify methods that can be used to evaluate public transport systems.

The second phase served to develop a methodology to describe and discuss urban public transport systems. A questionnaire was developed to interview stakeholders in the case cities of Cape Town, Dar es Salaam and Nairobi. These interviews were used to collect data and to obtain an understanding of the current public transport systems in these cities.

The third phase was the collection of data from case cities to translate the list of theoretical characteristics, goals, objectives and performance measures into a shorter practical list.

The fourth phase led to the development of the methodologies to evaluate and compare urban public transport systems (Annexure A), while the fifth phase applied the methodology to the three case cities (discussed in this paper).

### **3 APPLICATION ON METHODOLOGY ON CASE CITIES**

#### **3.1 Overview**

This section will discuss the results from the application of the methodology on the three case cities.

The first section will apply the methodology to describe and discuss the characteristics of the public transport systems of the case cities. A discussion on the results for the cities will follow. A review of literature produced a set of characteristics and components of public transport systems that are important to describe and discuss the public transport systems of cities. These were grouped into 23 components within 4 themes namely: institutional and regulatory framework, public transport network, public transport modes, and financial issues, whereby the public transport systems will be described and compared.

The second section will apply the methodology to evaluate and compare urban public transport systems on the case cities. The goals and objectives that were selected for each city are listed, as well as the chosen KPIs for all three cities together. A discussion on the data required, the evaluation of the KPIs as well as the analysis of the results will follow.

#### **3.2. Discussion of the public transport systems characteristics**

The transportation systems of all three cities suffer from institutional fragmentation across various institutions. There is a lack of coordination between the institutions and stakeholders involved for Nairobi and Dar es Salaam, while they are better coordinated for Cape Town. All three cities have legislation in place to regulate their public transport systems, although some of the key legislation in Nairobi is out-dated and in Dar es Salaam the policy framework is poor. This has a negative impact on public transport regulation. In all three cities the Paratransit services are not formalized and this deregulated market, especially in Nairobi and Dar es Salaam, has led to the domination of the public transport market by paratransit operators. Cape Town is well prepared in terms of policies and strategies available to provide an effective public transport system, but they tend to wait too long before implementing these policies. Nairobi lacks a clear urban transport policy to guide the public transport sector as they only have a draft Transport Policy. Dar es Salaam has a National Transport Policy, but they lack a policy specifically designed for public transport. Only Cape Town has a fare policy, subsidy policy and TDM policy.

Cape Town and Dar es Salaam have much larger land areas than Nairobi, and thus have low to average population densities, while Nairobi has a much higher population density. Low densities usually indicate urban sprawl, as in Cape Town and Dar es Salaam, which increases the financial costs for the government to provide infrastructure services in these areas. Urban sprawl also increases the cost of transport and travel time. Usually the poor, low-income households are situated on the urban periphery of cities and they have to spend the largest percentage of their monthly salary on transportation. Low density residential development does not support an efficient city-wide public transport system and service. Nairobi and Dar es Salaam both have radial networks with one CBD area which increases congestion along the major arterial roads leading to the CBD area, while Cape Town also has a main CBD area, with smaller business and commercial nodes and multi-purpose land use. This has helped to improve the traffic flow and congestion experienced on Cape Town's roads.

Cape Town has the largest road network with 8500 km, while Nairobi and Dar es Salaam both have networks of approximately 1150 km. The quality of the road network for Cape Town is much better than in Nairobi and Dar es Salaam. All the roads in Cape Town are paved, while most of the roads in Nairobi and Dar es Salaam are gravel roads. Cape Town and Nairobi have road- and rail-based public transport systems, while Dar es Salaam only has road-based public transport. Cape Town has more than 900 bus routes and 600 minibus-taxi routes, Nairobi has 50 bus routes and 125 Matatu routes and Dar es Salaam has 255 Daladala routes. Cape Town has the highest private vehicle modal share with the lowest public transport and NMT modal share. The modal shares for Nairobi and Dar es Salaam are very similar with 42% and 43% public transport share respectively. Commuter rail is the dominant public transport mode in Cape Town, while paratransit is the dominant transport mode in Nairobi and Dar es Salaam.

The commuter rail network in Cape Town is the most extensive of the three cities. Nairobi has a rail system that is almost non-existent as it provides only four commuter rail trips per day and Dar es Salaam does not have any commuter rail services. The public transport market share of bus services has declined in all three cities due to competition from the paratransit sector. The largest decline has been in Dar es Salaam, where commuter bus services now accounts for only 2% of the public transport market, while Cape Town has the largest modal share for commuter bus services. The paratransit services in all three cities operate in a deregulated environment. Nairobi and Dar es Salaam have a higher paratransit modal share than Cape Town, where it dominates the public transport market.

All three cities indicate vast disparities between the wealthiest and poorest communities. Most of the poor households are captive public transport users, while some cannot afford public transport and have to walk. Cape Town has a much higher GDP per capita than Nairobi and Dar es Salaam. The public transport fares charged in Cape Town range from US\$ 0.60 to US\$ 4.7, while the average fare charged in Nairobi is US\$ 0.26 and for Dar es Salaam it is between US\$ 0.20 and US\$ 0.27. All three cities have low income households that spend more than 10% of their household income on public transport services.

### 3.3 Assessment of the public transport systems

#### 3.3.1 *Goals and Objectives*

Public transport objectives will help to identify the performance measures that are necessary to evaluate public transport systems.

The vision for Cape Town's public transport is to provide *"A safe, effective, efficient, equitable and affordable public transport system that supports sustainable, social and economic development in an environmentally responsible manner."* (COCT, 2009)

The vision for public transport in Nairobi is to have *"a world-class transport system that is integrated and responsive to the needs of people and industry"* (NTPC, 2004), while the mission for public transport is *"to develop, operate and maintain an efficient, cost effective, reliable, safe, secure and integrated transport system and link transport policy with other sectoral policies, in order to achieve national and regional development aspirations in a socially, economically and environmentally sustainable manner"*. (NTPC, 2004)

The vision of Dar es Salaam is *"the growth and development of Dar es Salaam towards becoming a world-class city."* (DESCC, 2004) The aim of the National Transport Policy is *"to develop efficient and cost-effective domestic and international transport services to all*

segments of the population and sectors of the national economy with maximum safety and minimum environment degradation." (Thum, 2004)

From the goals and objectives for all three cities, the following are listed in all three and will be used to determine the KPIs for the evaluation of their public transport systems:

1. To promote public transport over private transport.
2. To improve the quality of the public transport service provided to meet the needs of all users.
3. To improve the safety and security of the public transport services.
4. To provide reliable public transport services.
5. To improve the accessibility of the public transport services to all.
6. To provide affordable public transport.
7. To provide an integrated public transport system across all modes.
8. To promote the use of NMT and public transport.
9. To provide universal accessible public transport services.

### 3.3.2 KPIs and data required to evaluate the objectives

For most of the objectives mentioned above, more than one KPI can be selected and used to evaluate the performance of the public transport system. These KPIs also need certain public transport data in order to be evaluated (see Table 1). The objectives that were selected in section 3.3.1 to estimate the KPIs are listed below with their KPIs:

**Table 1: KPIs & Data Required to evaluate the public transport objectives**

	Objective	KPI	Data required
1	To promote public transport over private transport.	% of motorised transport users using public transport.	# Motorised transport users. # Public Transport (PT) users.
		% of motorised transport users using private transport.	# Motorised transport users. # Private transport users.
		% of dedicated PT road km's out of the total road network for the city.	Dedicated PT lane km's. Total road-km's in city.
		Number of daily PT passengers per 1000 population.	Daily PT passenger volumes. Population size.
2	To improve the quality of public transport service provided to meet the needs of all users.	Average load factor in the peak period (passengers per seat).	# PT passengers in the peak period. # PT seats available in the peak period.
		% of Population that are satisfied with the PT service quality. % of sample surveys satisfied with PT services.	# Population that are satisfied with PT service quality. Population size, Sample size # Sample commuters that are satisfied with PT service quality.
		Average travel time to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel times per PT trip in the peak period.
		Peak-hour frequency of the PT services: -Rail, Bus, Paratransit	Peak-hour frequency (min).
3	To improve the safety and security of the public transport services	# Road accidents per 100,000 population.	Annual accidents. Population size.
		# Road Fatalities per 100,000 population.	Annual road fatalities. Population Size.
		# PT Crime-related incidents per year per 1000 population.	Annual crime-related PT incidents Population Size.
4	To provide reliable public transport services.	% of Scheduled PT services that arrives on-time.	# Scheduled PT trips (daily). # Of PT trips that arrives On-time.
5	To improve the accessibility of the public transport services to all.	% of Population within 1000 m walking distance from a PT facility.	# Population within 1000 m from PT facility. Population size.
		# PT stops per 100 km <sup>2</sup> .	# PT stops in city. Area of city

	Objective	KPI	Data required
6	To provide affordable public transport.	Average % of household income spent on PT services per month.	Monthly household income spent on PT. Monthly household income.
		Average % of per capita income spent on PT services.	Monthly per capita income spent on PT. Monthly per capita income.
		% of Public transport users that spent more than 10% of their household income on PT services.	# PT users that spent more than 10% of HH income on PT services per month. Total PT users. Average monthly household income. Average monthly PT expenditure.
		Average fare per PT trip.	PT fares per trip. # PT trips. Total monthly expenditure on PT. Number of monthly PT trips.
7	To provide an integrated public transport system across all modes.	% Population that has access to all three PT modes.	# People who have access to all three PT modes, Population size.
		% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities.	# PT modes that are integrated through ticketing. # PT modes that have coordinated schedules.
		# PT Facilities where passengers can transfer from one mode to any two PT modes.	# PT facilities that have modal interchange facilities. # Total PT modes and PT facilities
8	To promote the use of NMT and PT.	Modal split of the transportation system. - % PT, Private vehicle & NMT users	# PT users # Private vehicle users. # NMT users.
		% of Transport budget spent on investment in NMT and PT projects.	Gvt capital investment in NMT projects. Gvt capital investment in transportation.
		Are there efficient TDM Strategies for the city?	Yes/No?
9	To provide universal accessible public transport services	% of PT vehicles that provide universal accessible.	# Universal accessible PT vehicles. Total PT vehicle fleet
		% PT facilities that provide universal accessible.	# PT facilities that are universally accessible. Total # of PT facilities.

The KPIs listed above will be used in the next section to evaluate the performance of the PT systems of the case cities. In the case where some of the data required to evaluate a KPI were not available, the KPI will be excluded from the KPIs that will be used to compare the three cities against each other (section 3.3.3).

### 3.3.3 Evaluation of the KPIs of the case cities

The results for the selected KPIs for each case city are presented in table 2.

**Table 2: Results of the KPIs**

	KPI	Cape Town		Nairobi		Dar es Salaam	
1	% of Motorised transport users using public transport. (All day)	33%	(2004)	80,8%	(2002)	87,8%	(2002)
	% of Motorised transport users using private transport. (All day)	67%	(2004)	19,2%	(2002)	12,2%	(2002)
	% of Dedicated PT road km's out of the total road network for the city.	1%	(2009)	0%	(2009)	0%	(2009)
	Number of daily PT passengers per 1000 population.	365	(2004)	261,5	(2006)	462	(2006)
	Vehicle ownership per 1000 population	197	(2009)	23	(2002)	20	(2002)
		184	(2004)				

KPI	Cape Town		Nairobi		Dar es Salaam		
2	Average daily load factor (passengers per seat). - Rail - Bus - MBT	2.96 2.45 2.34	(2005)	4 4.29 2.54	(2002)	n.a. n.a. 5.13	(2002)
	Average travel time to work, for all public transport commuters during the morning peak period.	55 min	(2004)	58 min	(2006)	48 min	(2008)
	Total road-based public transport seat capacity per 1000 capita	81.31	(2005)	169.3	(2002)	125.5	(2002)
	Total public transport seat capacity per 1000 capita	146.78	(2002)	171.59	(2002)	125.5	(2002)
3	Accidents per 100,000 population	2,635	(2007)	302	(2002)	273	(2002)
	Fatalities per 100,000 population	11.91	(2007)	24.35	(2002)	17.05	(2002)
	Fatalities per 10,000 vehicles	4.07	(2009)	57.9	(2002)	46	(2002)
	Percentage of pedestrian casualties	53%	(2009)	37%	(2002)	42%	(2002)
4	% of Scheduled PT services that arrive on-time.	n.a.		n.a.		40%	(2004)
5	% of Population within 1000 m walking distance from a PT facility. (15min walk = 1000m)	91%	(2004)	73%	(2006)	n.a.	
	# PT stops per 100 km <sup>2</sup> .	181	(2009)	n.a.		n.a.	
6	Average % of household income spent on PT services per month.	5-10%	(2004)	10-15%	(2002)	17%	(2002)
	% of PT users that spent more than 10% of their household income on PT services.	23	(2004)	63	(2002)	55	(2002)
7	% Population that has access (within 1000m) to all PT modes in their city.	n.a.		n.a.		n.a.	
8	Modal Split		(2004)		(2002)		(2002)
	- NMT - Public transport - Private transport	13% 39% 48%		48% 42% 10%		45% 43% 6%	
	- Public transport - Private transport	33% 67%		80.8% 19.2%		87.8% 12.2%	
	Public transport Modal Split		(2004)		(2002)		(2002)
	- Rail - Bus - Paratransit	54% 17% 29%		1,5% 30% 68,5%		0% 2% 98%	
9	% of PT vehicles that are universal accessible.		(2009)				
	- Buses - Total (Road)	2.5% 0.35%		0%		0%	
	% PT facilities that are universal accessible.	n.a.		n.a.		n.a.	

Section 3.3.4 will discuss the results from the KPIs for the case cities.

### 3.3.4. Analysis of the results of the KPIs

#### *Promotion of public transport over private transport*

Public transport in Nairobi and Dar es Salaam has more than twice the transport market share than in Cape Town. Private vehicle ownership rate in Cape Town is much higher than in the other two cities (Cape Town at 200 cars/1000 people, Nairobi at 23 cars/1000 people and Dar es Salaam at 20 cars per 1000 people). It could be argued that in order for Cape Town to ensure that the objective of reaching a modal split of 50:50 (public: private) is possible, they need to improve their quality of public transport services and also promote TDM strategies to encourage people to start using public transport services.

### *Improvement of the quality of public transport service provided*

Public Transport commuters in all three cities are unhappy with the quality of public transport service provided. The standard and quality of public transport services need to be improved in order to provide a "World-class" public transport system. Dar es Salaam has the highest public transport load factor per day, this is mainly due to the high paratransit modal share (98% Daladala). Paratransit vehicles have lower capacity than buses or trains and thus need more vehicle trips to provide the same capacity as the larger buses or trains. This could also have an impact on the overcrowded conditions on Daladala in Dar es Salaam. The load factor for Nairobi for rail services is also quite high, mostly because there are only 60 coaches and only one trip per line direction per day. The trains in Cape Town are overcrowded during the peak period, but during the off-peak period the trains and buses experience low-utilisation rates.

Nairobi has the highest seat capacities per 1000 capita. This is mainly due to the large paratransit (Matatus) fleet in Nairobi and there might be less control on vehicle entry to the market. By comparing only the road-based public transport seat capacity per 1000 people, Cape Town has a much lower capacity than the rest, which indicates the importance of the railway service in Cape Town and that rail provides spaces that road vehicles do not need to provide.

### *Improvement of the safety and security of public transport services*

Cape Town has a much higher number of road accidents per 100,000 population than Nairobi and Dar es Salaam, while Nairobi has a higher ratio than Dar es Salaam. One of the reasons for the high number of accidents in Cape Town is that there are a larger number of registered vehicles in Cape Town; Cape Town has more than 10 times the number of registered vehicles compared with Nairobi and Dar es Salaam. Nairobi and Dar es Salaam most probably have fewer insured vehicles, which mean that the reporting of accidents is less, unless there is a fatality.

Although Cape Town has such a high number of accidents, Nairobi has the highest number of fatalities per 100,000 population which is 24.35, and Dar es Salaam has the second highest ratio at 17.05 fatalities per 100,000 population, while Cape Town has a ratio of 11.91. All three cities compare poorly against the European rates of 1,2 to 1,8 fatalities per 100,000 population (Pendakur, 2005).

### *Provision of reliable public transport services*

There is not enough information available on the reliability and on-time performance of the public transport modes in Cape Town and Nairobi, although interviews with passengers indicate that they are not satisfied with the current reliability and on-time performance of public transport services. The on-time performance of public transport services by Daladala in Dar es Salaam was estimated by making use of the study of Kanyama *et al.* (2004) in which they surveyed Daladala passengers and asked them to give a reliability percentage for the Daladala. From the survey results it was found that the average on-time performance is 40%, which is low and needs improvement.

### *Provision of public transport services that are accessible to everyone*

Cape Town has the most accessible public transport system with more than 90% of the population having access to public transport facilities or stops within 15 minutes walking (1000m) from their houses. 73% of the households in Nairobi can reach public transport facilities within a 1000m from their houses, which is also fairly high. Poor road conditions in the slum areas of Nairobi prevents public transport to access these areas and thus some households have to walk far to access public transport services. Urban sprawl, poor road



conditions and the road network layout of Dar es Salaam leads to a large number of people that have to walk more than 1km to access public transport services.

#### *Provision of affordable public transport services*

Dar es Salaam households on average spend the largest percentage of their monthly household income on public transport (17%). Households in Nairobi spend between 10 - 15% of their household income on public transport, while in Cape Town they spend between 5 - 10%. The percentage for Cape Town seems low, although this is due to the large income disparity in Cape Town. The real scenario is that households with the lowest monthly income spend more than 30% of their household income on public transport. This also happens in Nairobi and Dar es Salaam. The poorest households usually live the furthest away from the CBD and employment areas and they have to travel further and thus spend more per public transport trip. The affordability of public transport needs to improve for all three cities.

#### *Integrated public transport service provision*

There is not enough data and information available to assess this KPI. Cape Town is working towards an integrated public transport system, while the DART system in Dar es Salaam is also planning to achieve an integrated public transport system.

#### *Promotion of public transport service and NMT use*

Nairobi has the highest number of all daily trips per person (2,2), while Dar es Salaam has 1,96 trips and Cape Town has only 1,13 trips per person. The mobility rate suggested in Pendakur (2005) for a developing country is usually 3 trips per day, which indicates that the mobility rates for the latter two cities, are low. The following reasons are suggested for this: long trips, long travel times, high cost of transport and the absence of proper infrastructure facilities for NMT. The surveys in Cape Town might exclude walking trips and thus these rates might not be comparable against each other. The modal split for transport in Nairobi and Dar es Salaam is very similar, with NMT and public transport as the dominant modes. NMT in both cities has a share of more than 40%, while in Cape Town the modal share is very different. Private vehicles in Cape Town have the largest share (48%), then public transport (39%), while NMT only has a small modal share (13%).

#### *Provision of universal access public transport services*

There is no indication of public transport vehicles providing universal access in Nairobi and Dar es Salaam. The only vehicles that provided universal access in Cape Town, prior to 2010, are 30 special minibus-taxis that provide services for Special Needs Passengers. The buses for the BRT in Cape Town will have universal accessible facilities.

There is not enough data on the degree to which public transport facilities in all three cities provides universal access, although in Cape Town some of the public transport facilities do provide universal access. The policies for public transport in Cape Town are currently focusing on providing universally accessible public transport systems.

### 3.4. Assessment of the Methodology

#### *3.4.1. Describing and discussing the public transport systems*

This methodology was used to reduce the number of components and characteristics that are required to describe a public transport system. The application of this methodology to the case cities was successful although the chosen components and characteristics were still too many and provided too much information for a short summary on the public transport system of each city.

### 3.4.2. Data collection

A data collection tool was developed to collect public transport data from the case cities. Interviews in each city were held with public transport stakeholders in order to collect public transport data. The questionnaire was useful in the collection of public transport data, but the data collected from the interviews were not enough for the measurement of performance in the case cities and additional data had to be collected through secondary data and desktop studies. The questionnaire was maybe too long and can be improved by selectively reducing the number of questions.

### 3.4.3. Assessment of the performance of the public transport systems

This phase focused on the development of KPIs and the comparison of the calculated KPIs across the case cities by using a spread sheet model.

- The process of selecting the goals and objectives of a city in order to identify the KPIs worked very well, especially to ensure that the most important KPIs for a city are selected.
- For most objectives, one KPI can be selected from a set of KPIs to evaluate the performance of the public transport system.
- The socio-economic indicators of each city, e.g. income per capita, area and population, make it possible to contextualize the data for each city while estimating KPIs.
- It was difficult to collect all the data needed to evaluate the selected KPIs and careful consideration needs to be given to the time and resources required to collect the data versus the importance of the specific KPI.
- Some of the public transport data of the cities are not available for the same year and the data were selected from sources that were as close together in terms of the year, as possible. Growth factors might have to be used in order to make sure that the data used in the calculations are for the same year.

The spread sheet model (see Annexure A) developed to evaluate the performance of the public transport systems of the case cities was successful and efficient in the application process. The model assists in the determination of the most appropriate KPIs and calculates and compares each KPI across the cities.

The different phases of the methodology worked well together in this comprehensive study of the public transport systems of the case cities.

Section 4 will discuss the conclusions on the paper and makes recommendations for further research.

## 4. Conclusions and Recommendations

### 4.1. Performance of the public transport systems of the case cities

This study evaluated the performance of the public transport systems of three case cities through the use of different methodologies in order to describe, discuss and evaluate the public transport systems. The characteristics of the public transport systems in Nairobi and Dar es Salaam are very similar, with both markets dominated by paratransit services whereas Cape Town's PT market is dominated by commuter rail services. The characteristics of the public transport system in Cape Town is different from the other two cities, but all three cities have congested networks, poor quality of public transport services, struggles with the regulation of the paratransit services and have some of the population that cannot afford public transport.

The results from the KPIs once again showed that Nairobi and Dar es Salaam are very similar. Cape Town has a larger percentage of private vehicles which is probably because it has a much higher income per capita. It is recommended that all three cities need to improve the quality of service and performance of their public transport systems in order to reach the standards of a "World-class" public transport systems.

The study conducted in this research developed a methodology to collect data on which public transport systems can be described and discussed and also compared. This methodology includes a process to reduce the topics to be used to a more manageable list, a questionnaire for the collection of the data, a method to identify KPIs that are necessary, but at the same time appropriate within the data resources that are available and can be collected; the estimation of these KPI's; and (at this stage) a subjective assessment of the performance of the PT systems on the basis of the KPIs.

#### 4.2. Recommendations

It is recommended that the methodology used in this study can be improved with the following:

- By reducing the number of components and characteristics used to describe the public transport systems.
- A study is required to improve the method by which performance is rated more objectively (possibly by using Multi-Criteria Analysis).
- During the evaluation process, the data collection process of the data required to estimate the selected KPIs could be improved by shortening the amount of time that is necessary to collect the data. This can be done by building up a database of data for each city and updating this database on a regular basis. It is also vital that the user of the methodology understands each KPI in terms of the data required, the estimating process and also the interpretation of the results.
- The current methodology does not have benchmarks for each KPI listed, and it is suggested that additional research should be done to develop benchmarks (for the public transport systems of developing countries) for all the KPIs. Benchmarks are important as they can help to give a perspective on how good or bad the quality of PT service is for each city.
- Additional research on user preference and perception of the quality of the public transport systems for each city should be done, as current information is inadequate.

The methodology used in this research is user-friendly and easy to understand and enables us to undertake a comprehensive study on the public transport systems of a city. This research process is very valuable as it provides relevant information on the quality of public transport systems which is especially valuable as most African cities are struggling to improve the equality of their public transport systems. The KPI results are able to indicate to government and stakeholders where the problem areas are and how they compare with other cities.

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## ANNEXURE A: ASSESSMENT METHODOLOGY

The Assessment model has four steps namely:

a) Step 1 involves the process of choosing the goals and objectives from the list of possible goals, objectives and related KPIs.

b) Step 2 involves the process of choosing the KPIs; this will be done with the help of selection criteria. After the KPIs are chosen the data required for each KPI will be presented.

c) The user can go to step 3 to enter the data required, the user can change the KPIs selected or could even go back to step 1 to unselect some of the goals and objectives selected. During step 3 the data required to calculate the KPIs will be entered by the user. There is an iterative process between steps 2 and 3 to input the required data.

d) Step 4 calculates the KPIs and produces the output.

