



**Sustainability Assessment of a Bus Rapid Transit (BRT) System:  
The Case of Dar es Salaam, Tanzania**



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## **Abstract**

This paper examines how Dar es Salaam's public transport conditions compare in terms of sustainability before and after the introduction of a proposed BRT system, so-called DART (for Dar Rapid Transit). The system was proposed in order to improve the infrastructure for commuters in the city and alleviate the air pollution problems within the existing system.

The project is expected to be fully implemented by 2030 with three-fourths of its finances coming from the World Bank and the rest from the government of Tanzania (Dar es Salaam City Council, 2007).

The choice of introducing the proposed BRT system into Dar was analyzed through a survey of the attitudes of the users and operators of the existing system and the private car commuters in the city. Interviews were also held with the planners of the systems as well as the officials working closely with the public transport sector of the city.

The proposed system has numerous evident gains in terms of alleviating the urban mobility challenges in the city. Nevertheless, it also has the shortcomings that its services is not equitably distributed across population groups; its contributions to emissions reductions demand support from mechanisms that limit private car commuting; and its planning does not duly involve the current public transport operators.

**Keywords:** Urban Mobility, Bus Rapid Transit (BRT), Public Transport, Sustainable Transport, Sustainability, Daladalas, Emissions, Dar es Salaam

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## List of Acronyms

AAMA	American Automobile Manufacturers Association
BRT	Bus Rapid Transit
DARCOBOA	Dar es Salaam Commuters Bus Owners Association
DART	Dar Rapid Transit
DCC	Dar es Salaam City Council
EWURA	Energy and Water Utilities Regulatory Authority
GTZ	German Technical Cooperation
ITDP	Institute for Transportation and Policy
JICA	Japan International Cooperation Agency
NBS	National Bureau of Statistics
NEMC	National Environmental Management Council
OECD	Organization for Economic Cooperation and Development
SCCC	Sumatra Consumers Consultative Council
SSATP	Sub-Saharan Africa Transport Policy
SUMATRA	Surface and Marine Transport Agency
TZS	Tanzanian Shillings
UEMOA	West African Economic and Monetary Union
UN	United Nations
UNFPA	United Nations Population Fund
US EPA	United States Environmental Protection Agency
WCED	World Commission on Environment and Development
WUP	UN World Urbanization Prospects

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Merahi Ahferom

## **Cover Photo**

Dar Rapid Transit (DART) demonstration model, by Merahi Ahferom

# 1. Introduction

Although travel has been part of a human experience for many centuries, the 20<sup>th</sup> century seems to have depicted a quite distinct experience (OECD, 2000). The century happens to be characterized by remarkable rates of growth in population, mobility and urbanization such that, globally, motorized transport increased by more than one hundred fold while population increased by fourfold (AAMA, 1998 in OECD, 2000). Along with these changes, urban land has been rapidly expanding due to the modern patterns of city growth that are land-intensive as well as the improvements in transportation services that made commuting easier (UNFPA, 2007). The sum total of these phenomena has thus been a continuing movement of people resulting in tremendous growth of urban areas (UNFPA, 2004). Accordingly, at present, for the first time in history, more than half of the world's population dwells in cities and it is estimated that all regions of the world will have urban majorities by 2030 (Ibid). This gives urban areas, and the issues related to them, an increasing importance in contemporary socio-economic and environmental discussions. Following is a brief discussion of the aforementioned factors as driving forces to urban transportation.

## 1.1. Population Growth and Urbanization

The increasingly trend of urbanization worldwide can be demonstrated using the rapid increase over the past decades in urban population in almost all regions of the world (UNFPA, 2004). According to the United Nations World Urbanization Prospects, WUP (2005), urban population has grown from 29% in 1950 and 37.2% in 1975 to 48.7% in 2005. That represented an annual rate of change of 2.65% which was more than double the rate for rural population, 1.12% (Ibid). Following this increasing trend, it is estimated that the global urban population will reach as much as 5 billion by 2030, which would represent 60% of the world's population (UNFPA, 2004).

Although both developed and developing countries have been experiencing an increase in urban population, the rates of change in these regions vary greatly. According to WUP (2005), the urban population in developing countries increased annually at 3.61% between 1950 and 2005 while developed countries had the increase at only 1.37% per year. Likewise, these rates are estimated to be 2.20% and 0.47% for developing and developed countries, respectively, over the years between 2005 and 2030 (Ibid). This is quite plausible as *internal migration* (i.e. the movement of people within a country) from rural areas to urban areas is high in the developing world for several reasons (UNFPA, 2004). The most important ones appear to be the so-called *demand pull* and *supply push* factors that denote productivity and monetary reward prospects in urban areas and rural poverty due to traditional agriculture (Barrios *et al.*, 2006). While social

changes induced by need for higher education, rising incomes, and emerging life styles are other reasons (Button and Nijkamp, 1997).

Being an African city, Dar es Salaam has for decades been experiencing rapid population growth. Olvera *et al.* (2003) states, for example, that the population of the city grew at an annual growth rate of 9.4% between 1968 and 1978 and at 4.7% between 1978 and 1988. The past decades showed similar patterns such that the population of the city reached 2.5 million by 2002, doubling the population since 1988 (Lupala, 2002). Currently, the population growth rate of the city is estimated to be 4.1% (JICA, 2008). This denotes a pressure directly exerted on the transport demand in the city, be it in terms of the need for more vehicles or the need to commute longer due to a geographical growth of the city.

## **1.2. Urban Sprawl**

In accordance with the observed population growth in urban centers, almost all cities throughout the world experience expansion in their geographical space (UNFPA, 2007). This assumes different reasons in different parts of the world. In the developed world, and particularly in North America, urban sprawl results largely as people move into suburban areas in search of a higher quality of living (Whitehand and Larkham, 1992). While in the developing world, and typically in African countries, urban sprawl occurs as people build illegal houses in the peripheries of cities and render cheap rental conditions thereby attracting more and more settlers (Ibid; Habitat, 1996a).

Driven largely by the factors mentioned above, the surface area of Dar es Salaam has increased rapidly over the past decades. Maunder and Fouracre (1987) (in Olvera *et al.*, 2003) state, for example, that the land coverage of the city increased by a factor of five between 1968 and 1982. Likewise, Lupala (2002) records the geographic growth of the city during the period between 1963 and 2001 to be an increase by more than 18 times (from 3,081 ha to 57,211 ha). Presenting this differently, Kombe (1994) (in Olvera *et al.*, 2003) shows that the distance from the city center to the edge has increased from 15 km in 1978 to 30 km by the mid 1990s. Currently Dar es Salaam has a size of about 1800 km<sup>2</sup> (JICA, 2008; Halla, 2004).

## **1.3. Statement of the Problem**

### **1.3.1. Transport Demand**

Burdened with a rapid population growth and city expansion, Dar es Salaam's transport sector depicts a situation where the gap between public transportation needs and provision is continuously widening (Olvera *et al.*, 2003). This situation has been worsened as public transport is the only alternative for the poor. Two World Bank surveys done in 1994 and 1996 show, for

example, that about 43% of all the trips done in Dar es Salaam were done using public transport, whereas only 7% of these trips were done with cars and motorbikes and 3% by bicycles (SSATP, 2005). A recent study by Kombe *et al.* (2003) (in Kanyama *et al.*, 2004) also shows that as much as 60% of all trips made in the city are done on buses.

Furthermore, the city's transport sector is burdened with high travel demand soaring from the uneven distribution of public and private facilities within the city (SSATP, 2005). This denotes, firstly, a concentration of employment and market opportunities in the city center. According to Olvera *et al.* (2003), for example, Dar es Salaam's main urban facilities – its port, the main hospital, the largest market and the commercial district (Kariakoo) – are all located in the center of the city which obliges the inhabitants to commute to access the opportunities there. And secondly, it denotes lack of services, as schools and health units, within or close to residential areas that makes commuting unavoidable. Olvera *et al.* (2003) demonstrates this by analyzing a 1993 Dar es Salaam Human Resources and Development Survey that the closest public secondary school and the closest public hospital are located on average at 4.8 km and 3.9 km, respectively, away from any home in the city, with higher figures for poor neighborhoods. The private alternatives are on average 3.9 km and 5.4 km away (Ibid).

Although the figures given above duly portray the level of stress on the public transport in the city, accurate information can be gained by looking at the overall travel demand. A 2007 survey done by the Japan International Cooperation Agency (JICA) has established that 2.87 million trips per day are made in total in the city using all modes of transport and that 2.13 million (74%) of those trips are made by motorized modes (JICA, 2008).

### **1.3.2. Transport Delivery**

The present public passenger transport system is composed of about 7000 buses, about 4000 taxis and a certain number of rickshaws (SUMATRA, 2009, Illala Municipal Council, 2009). All of these vehicles are owned and operated by private entrepreneurs (Ibid). The buses, so-called daladalas, dominate the public transport delivery in the city (SSATP, 2005). The service provided by daladalas is rather hideous. A comprehensive report by Kanyama *et al.* (2004), for example, evaluates their service poor and chaotic. The article elaborates that daladalas are unscheduled and thus incur long travel times; they have bad seat arrangements, overload passengers, not follow allocated routes, speed and drive recklessly, etc. The report argues also that most daladalas are “not only second-hand but third-hand or fourth-hand or more” that they emit large amount of pollutants and Carbon Dioxide (CO<sub>2</sub>).

### **1.3.3. DART, a proposed Bus Rapid Transit (BRT) system**

To mitigate the aforementioned public transport challenges, a Bus Rapid Transit system – so-called DART, for Dar Rapid Transit – has been proposed since 2003 and succeeded in gaining sufficient funding and political will to be fully implemented by 2030 (JICA, 2008). It is a citywide 137 km system designed to completely replace daladala<sup>1</sup> (Ibid) (See completed route map in Appendix C). It is therefore expected to provide reliable and comfortable trips with short travel times as its buses run on exclusive and segregated lanes<sup>2</sup>. It is also expected to be more environmentally friendly (and sustainable) as its buses will be EURO 3 standard and thus less polluting than daladala<sup>3</sup>.

### **1.4. Objectives of the Study**

The main objective of the study is to evaluate from a sustainability point of view (discussed in later sections) the choice made to introduce a BRT system into the city of Dar es Salaam. It raises some sustainability issues and examines whether or not they have been duly considered prior to making the choice. Meanwhile, therefore, the study examines the future of Dar es Salaam's transport sector and the changes that will be brought about by the introduction of a BRT system. The motive here is, on one hand, that a concrete understanding of the future will enable DART's planners and other stakeholders to take measures in the present day based on foreseen outcomes so as to ensure the intended ones and avoid undesired ones. While, on the other hand, by looking at this assessment other cities can make lessons on issues that need careful consideration before a decision to introduce such a system.

### **1.5. Research Questions**

The main research question is:

“How does Dar's public transport conditions in terms of sustainability compare before and after DART?”

In order to answer this general question, the following specific questions have been developed:

1. Would the BRT buses ensure equitable access to all population groups in the city?
2. Does the new system accommodate the current public transport operators?
3. How does vehicular emissions of CO<sub>2</sub>, CO and Nox in the city compare before and after the BRT compare?

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<sup>1</sup> Also fieldwork interviews with DART, 18 - 30 Feb. 2009

<sup>2</sup> Fieldwork interviews with DART and SUMATRA, 18 - 30 Feb. 2009

<sup>3</sup> Ibid 1

## 1.6. Boundaries

This study focuses on Dar es Salaam and its urban transportation conditions over a short- and medium- term time perspective. Informal power arenas, such as corruption, nepotism and lobby group activities, are not covered in this paper.

## 2. Theory

Alike the concepts of sustainability and sustainable development, sustainable transport happens to be one of the most argued concepts (Black, 2000; Gudmundsson, 2004). Sustainable transport has in fact been distinctively a subject of divergence for quite a while to the point that a consensus has not yet been reached (Gudmundsson, 2004). This is partly because transportation immensely integrates itself to a number of other activities as production, land-use, and life-styles and partly because concepts developed on it vary depending on the perspectives and interests of the parties that develop them (Ibid; Jeon and Amekduzi, 2005). Although this problem seems limited to conceptual issues, it has been observed that it seriously affects the practical matters that follow the conceptualizations (Gudmunsson, 2004).

Almost all definitions of sustainable transport center their conceptualization on the definition of sustainable development by its predecessor, the World Commission on Environment and Development, WCED (1987): “*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*”. Breaking this down, a number of researchers – according to Black (2000) – adopt the following three points. One, a transport system should primarily run on renewable resources and the rate of reproduction should not exceed their natural rate; two, and when the system uses non-renewable resources, the rate of use must not exceed the rate at which alternatives are developed; and three, the rate of emission of pollutants should not exceed the ability of the environment to assimilate it. Although this looks quite comprehensive, it clearly limits itself to environmental protection imperatives. As a result, the OECD for example identifies such a definition as a definition of only an *environmentally sustainable transport* (Ibid).

Sustainable transportation should be much more than just environmentally sustainable. That is generally because there are numerous economic (e.g. affordability) and social (e.g. equitable access) issues that a sustainable transport system should address. Integrating these issues, thus, takes us back once again to the conceptualization of sustainability by the WCED (1987): environmentally, economically and socially sustainable.

Based on this, therefore, Gudmundsson and Hojer (1996) have adapted the following sustainable development principles directly into transport systems: safeguarding a natural resource base,

maintaining the “option value of a productive capital base for future generations”, improving the quality of life of individuals, and equitably distributing the added life quality. Likewise, Transport Canada (2001) (in Jeon and Amekduzi, 2005), a Canadian government agency, has developed a competent set of sustainable transport principles and indicators based on the principles of sustainable development. Those are safety and health, access and choice, and quality of life as social sustainability indicators; efficiency, cost internalization, and affordability as economic sustainability indicators; pollution prevention and protection, and environmental stewardship as environmental sustainability indicators; and leadership and integration, precautionary principle, accountability, and consultation and public participation as managerial competency indicators.

Summarizing the aforementioned definitions, this paper agrees with Litman (1999) in conceptualizing sustainable transport as a system that is planned in such a way that it favors economic efficiency, is distributed equitably and causes no or the least environmental harm. This definition therefore chiefly guides the design of the methods used in this study and the analyses and discussions advanced.

### **3. Materials and Methods**

#### **3.1. Research Strategy**

In view of the nature of the transport challenges discussed above and the theories that explain them, this study has both quantitative and qualitative aspects. Yet, the analyses of the study tend to predominantly lean on quantitative data in generating arguments. This was largely due to the “forecasting” nature of analyses needed in explaining a system that is not yet in practice (Bryman, 2000).

#### **3.2. Research Design**

In accordance to Yin (2003)’s recommendation, this study was designed into a case study – one that illuminates a decision or set of decisions within its real-life context. The case was further designed to be an *exemplifying case*, a case chosen not for being extreme or unusual in some way rather because it “provides a suitable context for certain research questions to be answered” (Bryman, 2004).

Hence, the study examined one sustainable urban mobility option – a BRT system. The system has been identified from an array of other sustainable urban mobility options (specifically the light rail transit, the urban rail and the underground metro) because it incurs the least implementation cost (Dar es Salaam City Council, 2007). Then the case of Dar es Salaam, Tanzania was identified in order to highlight the aspects that need to be considered in

introducing such a system and to produce useful information for other cities with similar contexts. The study further plays a special *exemplifying* role due to the fact that DART is vying to be the first BRT system introduced in Africa (ITDP, 2007).

### 3.3. Methodology

#### 3.3.1. Study Area

The study area of this research covers the whole of Dar es Salaam metropolitan area which refers to an area of approximately 1800 km<sup>2</sup> and a population of 2.5 million according to a 2002 census (Population and Housing Census, 2002; Halla, 2004). Dar es Salaam is the largest city in Tanzania, seven times larger than the second biggest city in the country - Mwanza (Government of Tanzania, 2002 in Kanyama, 2004). It is also the most active commercial city in the country generating as much as 70% of the national internal revenue (Mlambo and Khayesi, 2006). Administratively, the city is divided into three municipalities so-called Kinondoni, Temeke and Ilala, shown below in the figure below (Fig.1) (Ibid).



**Figure 1: Map of Dar es Salaam**  
Source: Mlambo and Khayesi (2006)

Authorized by a 1997 Transport and Licensing act, public transport in Dar es Salaam is managed by a combination of the city's authorities (Kanyama *et al.*, 2004). The DART Agency (bodied directly under the Ministry of Local Affairs) currently has the jurisdiction of planning and executing the DART project. While, a national organization called Surface and Marine Transport

Regulatory Authority (SUMATRA), provides the regulatory basis for the daladala operating in the city<sup>4</sup>. It regulates among other things their numbers, routes and fares<sup>5</sup>. The municipal council of Illala on the other hand regulates the numbers and licenses of Taxis<sup>6</sup>. The Dar es Salaam City Council (formed from the three municipal councils and some members of the national parliament) follows up the urban mobility challenges in the city through its Urban Planning Section<sup>7</sup>.

These bodies work with several other national and regional organizations, some of which provide them with guidelines while others represent users and operators of the existing system. The Energy and Water Utilities Regulatory Authority (EWURA) regulates fuel prices and provides guidelines for public transport fares. The National Environmental Management Council (NEMC) advances environmental protection imperatives in regulating the public transport vehicles. Representing public transport users in the city is an organization called Sumatra Consumers Consultative Council (SCCC). Daladala operators are, on the other hand, represented by an association called Dar es Salaam Commuters Bus Owners Association (DARCOBOA). Currently, about 30% of the daladala operators in the city are members to this association<sup>8</sup>.

### **3.3.2. Study Population and Sample Size**

A total of 270 questionnaires were disseminated and about 10 open-ended interviews were conducted within a study population that comprised users, operators, planners and regulatory bodies in the city. The questionnaires were distributed among three groups identified within the dwellers of the city. One group comprised people who own private vehicles and thus largely commute on individual transport. The second group comprised public transport commuters. And the third group comprised the current public transport operators. The questionnaires thus involved different questions for the three groups. Response was collected from 60 daladala drivers, 60 car commuters and 150 public transport commuters.

### **3.3.3. Data Collection**

Empirical data was collected in this study using the *triangulated approach* (Bryman, 2004). This was done to enhance the *reliability* of the data (Ibid; Yin, 2003). The methods used were consulting articles and documents; making observations; and collecting questionnaire responses and conducting interviews. The execution of the latter two methods is briefly discussed below.

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<sup>4</sup> Fieldwork interviews with SUMATRA, 18 - 30 Feb. 2009

<sup>5</sup> Ibid

<sup>6</sup> Ibid

<sup>7</sup> Fieldwork interviews with DART, 18 - 30 Feb. 2009

<sup>8</sup> Fieldwork interviews with DARCOBOA, 18 - 30 Feb. 2009

**Observations:** In line with Yin (2003)'s recommendations, both *non-participant* and *participant observations* were made. The researcher had physically been to Dar es Salaam on fieldwork. Non-participant observation was intensively made during the first week (Feb. 18-25, 2009) by strolling in different parts of the city and sitting in bus stops and terminals just noting the public transport conditions and the behavior of the users and the operators. This was coupled with participant observations done over Feb. 18 to Mar. 7, 2009 where the researcher himself took different modes of public transport and commuted in the city. These observations assisted restructuring some of the research questions besides paving a way for a narrative explanation.

**Questionnaires and Interviews:** Once the general picture of Dar es Salaam's public transport has been gained, the questionnaire designed at the outset of the study for the public transport commuters was slightly modified. Two other questionnaires, one for daladala drivers and another for private car commuters, were also prepared (See Appendix A). Aware of the big mix of educational levels, the questionnaires were translated from English to Kiswahili in an effort to accommodate most of the local people. The translation was made by Mr. Mwemezi Rwiza who is Tanzanian and also a master's student of Environmental Studies and Sustainability at Lund University, Sweden which made the communication of concepts very simple.

The questionnaires were then distributed. The public transport users were contacted in bus terminals, at bus stops and to a small extent in their neighborhood. In doing this, *simple sampling technique* was employed. That is, respondents were contacted randomly and unannounced and then requested to fill the questionnaires. In terms of localities, the bus terminals Ubungu and Mwenge and the bus stops at Kariakoo and Survey Street were the main locations where the questionnaires were distributed. Other places were the Ardhi University cafeteria and the areas between and around Survey and Mwenge. Likewise, private car commuters were contacted around the areas mentioned above as they stop in parking lots, at cafes, shops and their work places. Questionnaires from daladala drivers were collected at Ubungu and Mwenge bus terminals as they enter the terminal and wait on a queue before their return trip. All questionnaires were distributed between 11am and 5pm, Tanzanian time.

In conducting the in-depth interviews, *purposive sampling* technique was used in order to identify the organizations that are closely involved with the subject in discussion. Accordingly, interviews were conducted with officers from the following offices: Dar Rapid Transit Agency (DART), Surface and Marine Transport Authority (SUMATRA), Energy and Water Utilities Regulatory Authority (EWURA), Dar es Salaam City Council, National Environmental Management Council (NEMC), Sumatra Consumers Consultative Council (SCCC), Dar es Salaam Commuters Bus Owners Association (DARCOBOA) and Illala Municipal Council.

### 3.3.4. Data Analysis and Interpretation

The collected data were analyzed in two stages. The first stage evaluates the degree of people's satisfaction / dissatisfaction with the existing system. It looks at the travel behavior of the people and their perceptions on the costs of commuting with public transport. It questions why people ride on the different transport means they ride today, thereby questioning their attitude towards a new and advanced public transport system.

The second stage examines DART's implementation proposal. It analyzes the number of vehicles (BRT busses, daladals and privately owned vehicles) that will be taken into and / or out of the streets after implementation phases I and II, which will be in 2010 and 2015 respectively.

## 4. Case Study Findings

### 4.1.Characteristics of the Sampled Population

The socio-economic and demographic information collected in the questionnaires was statistically analyzed and compared with already established data for the city. The table below (Table 1) presents this comparison for the public transport commuters.

**Table 1: Comparison of Sample Respondents with Dar es Salaam Population**

Parameters	Relative Frequency (%)	
	Within Sample (n = 150)	Within Dar es Salaam Population
Gender		
Male	78.8	50.5
Female	21.2	49.6
Total (%)	100.0	100.0
Source: Population & Housing Census, 2002		
Age		
Under 18	0.7	Missing data
18 to 30	72.3	Missing data
31 to 60	26.3	26.7
Above 60	0.7	3.2
Total (%)	100.0	--
Source: Population & Housing Census (2002)		
Educational Level		

No education	1.3	7.8
Primary	18.7	80.4
Secondary School	28.7	1.7
College	12.0	4.4
University	39.3	5.7
Total (%)	100.0	100.0

Source: Household Budget Survey (2000/01)

The gender composition within the sampled public transport users shows that 78.8% of them were male and 21.2% were female; while their age structure shows that 72.3% of them were between 18 and 30 years, 26.3% between 31 & 60 years and 0.7% each were under 18 and above 60 years of age. In analyzing the educational level of respondents, it was found that 39% of them have had university studies, 12% college studies, 28% secondary education, 18% primary education and 1.3% no formal education.

The socio-economic and demographic information gathered from daladala drivers and car commuters has also been compared with that of the public transport commuters. This is summarized in the table below (Table 2).

**Table 2: Comparison of Socio-economic and demographic information within respondents**

Parameters	Relative Frequency (%)		
	Public transport commuters (n=150)	Daladala drivers (n=60)	Private car commuters (n=60)
<b>Gender</b>			
Male	78.8	100.0	86.2
Female	21.2	0.0	13.8
Total	100.0	100.0	100.0
<b>Age</b>			
Under 18	0.7	0	1.7
18 to 30	72.3	40	33.3
31 to 60	26.3	60	64.9
Above 60	0.7	0.0	0.0
Total	100.0	100.0	100.0
<b>Educational level</b>			

None	1.3	3.3	0.0
Primary	18.7	56.7	8.5
Secondary	28.7	40.0	27.1
College	12.0	0.0	20.3
University	39.3	0.0	44.1
Total	100.0	100.0	100.0

It can be seen in Table 2 that all daladala drivers and 86.2% of the car commuters are male. In terms of age groups, the analysis shows that 40% of the daladala drivers are between 18 and 30 years old while the remaining (60%) are 30 to 60 years old. About 65% of the car commuters are between the ages 30 to 60 while 33% are between 18 and 30 and 1.7% are under 18 years. It was further found that 57% of the daladala drivers have had secondary education while 40% of them had primary education and the remaining 3.3% had none. In comparison, the results for private car commuters show that 44% of them attained university studies, 20% college studies, 27% secondary and 9% no formal education.

Further examining socio-economic conditions, respondents were asked about their incomes. The table below (Table 3) presents the median individual and family incomes within sample groups.

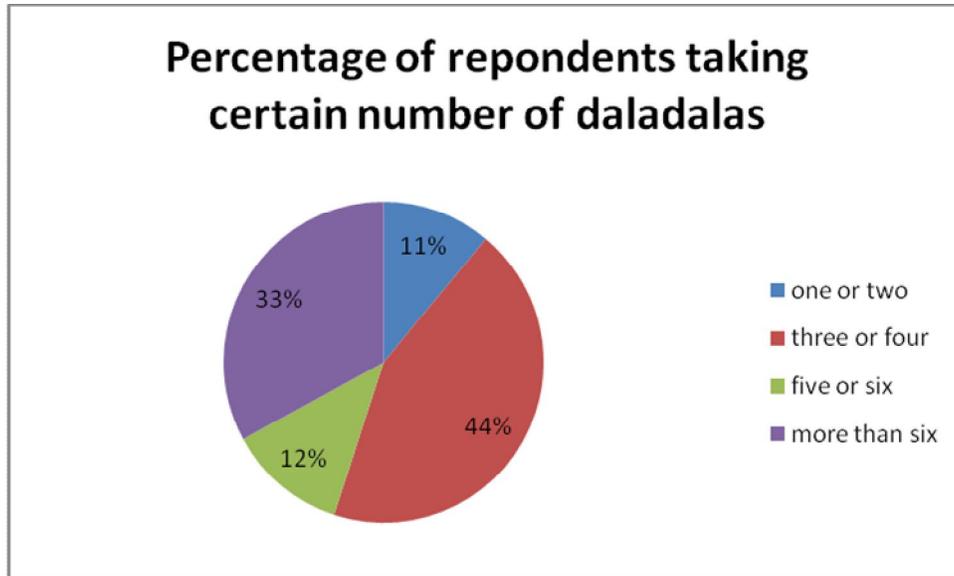
**Table 3: The median individual and family incomes within the case study groups.**

Group	Median Individual Income (TZS <sup>9</sup> )	Median Family Income (TZS)
Public transport commuters	150,000	200,000
Daladala drivers	300,000	350,000
Private car commuters	300,000	650,000

## 4.2. Current Public Transport Users

The responses gathered from public transport commuters revealed that 70% of them commute every day while 15% of them each commute two to three times and four to six times a week, respectively. It was found that 94.1% of the commuters usually use daladalas whereas only 3.9% of them use rickshaws and 2.0% of them use taxis. Further, respondents were asked how many daladalas they take throughout the day and the result is summarized in the pie chart below (Fig. 2).

<sup>9</sup>TZS 1 = €0.00061 (average for 25 Feb - 06 Mar 2009, <http://www.oanda.com/convert/fxhistory>)

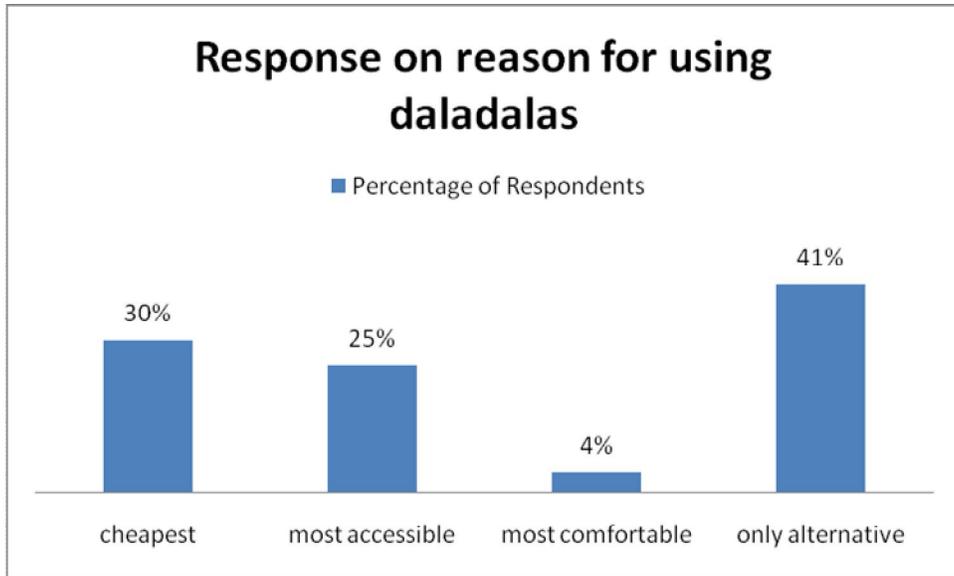


**Figure 2: Percentage of respondents taking certain numbers of daladalas per day (n=150)**

The chart above (Fig. 2) illustrates that 33% of the daladala commuters take more than six daladalas per day while 12% of them take five or six daladalas, 44% take three or four and 11% take one or two daladalas.

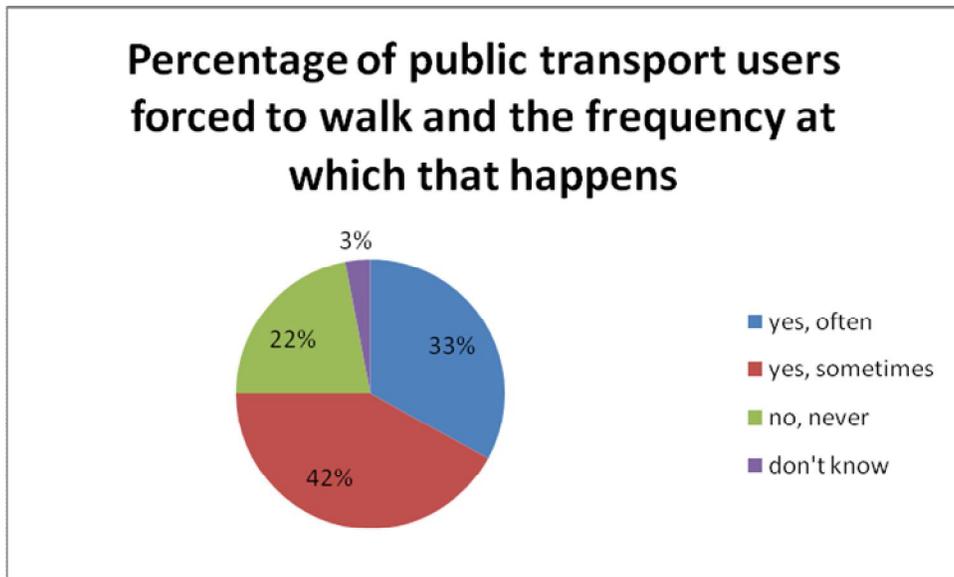
Respondents were given stated choices to answer as to why they commute with daladalas and not walk or cycle. The results show that 87% of the public transport riders think their destinations are too far to walk while 6% of them avoid walking in fear of traffic accidents. The remaining 7% gave reasons some of which were: *“I’m too weak to walk.”*; *“The sun is fierce.”* and *“It is time consuming because streets are usually crowded.”* For not cycling, 39% of the respondents claimed that they are forced to take public transport due to the lack of cycling lanes; while 29% of them said they can’t afford buying a bicycle and 32% of them gave other reasons. Of these, 74% of them did not specify their reasons, 11% of them stated that the fear of traffic accidents stops them from cycling and 6% of them said they do not have the riding skills. Other reasons given were: *“Cycling is tiresome.”*; *“I do not enjoy it.”*; and *“My destination is far.”* Each of these reasons was stated by 3% of this group.

Respondents also stated their reasons for using daladalas. As illustrated in the graph below (Fig. 3), it was found that 41% of them said it is their only alternative while 30% of them said it is their cheapest alternative; and 25% of them claimed it is the most accessible for them while 4% of them thought it is the most comfortable.



**Figure 3: Reasons of respondents for commuting with daladalas (n=150)**

Responses on current travelling costs showed that 35% and 43% of the daladala commuters think current fares are “very expensive” and “expensive”, respectively; while 20% of the respondents think fares are “moderate” and 1% of them each checked the boxes for fares are “cheap” and “very cheap”. Respondents were given stated choices on being forced to walk because of not affording the trips at times and their response is summarized in the figure below (Fig. 4).



**Figure 4: Percentage of public transport users who are occasionally forced to walk (n=150)**

### 4.3.Private Car Commuters

It was found that 43% of the private car commuters drive because they lack a decent<sup>10</sup> public transport alternative while 42% of them drive in need of better accessibility<sup>11</sup>. The results further showed that 10% of them drive because driving is currently inexpensive while 5% of them do so to keep their social status. The results for adopting a decent public transport thus show that 40% of them think that they will use it at all times while 38% and 18% consider using it most times and sometimes, respectively; followed by 4% of them who do not at all think of commuting on it. Further, provided there is a decent public transport option only between Ubungo and Posta, 71% of the respondents said that they will take it as they travel in those lines, while the remaining 29% said they will still take their car.

In line with these questions, a question was asked to see how these commuters respond to higher fuel prices. It was found out that if the fuel prices rise by 10%, then 19% will stop taking their cars, 48% would drive only a few days per week while 33% will not change their current driving levels. It was further found out that an increase by 25% in fuel prices will stop 23% of these commuters, while limiting 50% of them to drive over only few days per week. 27% will still remain unaffected.

Finally, respondents were asked about the type of engine their cars have and their running costs. The result showed that 78% of them run on petrol while the other 22% have diesel-engines. The table below (Table 4) summarizes the other results on these questions.

**Table 4: Expenditures in driving in Dar es Salaam and the fuel economy of cars**

Engine type	Expenditure in TZS (Median Value)			Fuel Economy (km/l)
	Fuel (per day)	oils (per week)	Maintenance (per month)	
Petrol	10,000	5,000	50,000	10
Diesel	20,000	15,000	50,000	10

### 4.4.Daladala Drivers

It was found that 78% of the daladala drivers are employed while 22% of them are operated by the owner himself. Asked whether or not they would leave the city if not permitted to operate, it was found that 50% of the daladala drivers who also own the vehicle intend to leave the city and operate in other cities. The other half said they do not know what they would do about it. Of the employed drivers, 83% of them said that they do not know how the owner would respond while 3% of them said the owner would leave the city and 13% of them said the owner would sell the vehicle but will not leave Dar.

<sup>10</sup> defined for them as more comfortable, faster and reliable (See Appendix A)

<sup>11</sup> defined for them as the distance to and from the nearest bus stop to their homes and workplaces (See Appendix A)

It was also found that 60% of the daladala drivers think there is need for more daladalas in the city throughout the day while 28% of them see that need only at peak hours and 12% of them do not see any need for more daladalas at all. The daladala drivers were asked a personal question on whether or not they would be interested to work as a driver in Dar in a bus owned by the government or a corporate at a monthly salary of 130,000 TZS. It was found that 58% of them would take the job right away while 5% said they would do so only if daladalas are banned in the city. The remaining 37% of the daladala drivers said they would decline the offer.

Questions were asked to the daladala drivers about their expenditures on fuel, oil and maintenance. The result has been summarized in the table below (Table 5).

**Table 5: Expenses of Daladala operators**

Vehicle type	Expenditure in TZS (Median Value)		
	Fuel (per day)	oils (per week)	Maintenance (per month)
Daladala	55,000	15,000	50,000

#### 4.5. In-depth Interviews

In-depth interviews were conducted with eight different offices in the city. The interviews focused on the role of the office in intervening with the existing public transport system, the mechanisms they employ, and their interests and concerns. The table below (Table 6) recapitulates the information gathered through these interviews.

**Table 6: Summary of the findings from the interviews held with officials in Dar es Salaam**

Stakeholder	Role/Interest/Concern
Dar Rapid Transit Agency (DART). <u>Delegate:</u> Mrs. Asteria Mlambo, DART Coordinator	<ul style="list-style-type: none"> <li>- Currently in charge of the BRT project, which aims to phase-out daladalas so as to modernize the public transport supply in the city</li> <li>- the office plans to charge people higher fares (if approved by SUMATRA) than present daladala fares in return of the improved quality of service</li> <li>- Plans to run BRTs without subsidy by renting the system out to giant private/corporate operators</li> <li>- Intends to involve daladala operators by employing present-day daladala drivers who have secondary education and above</li> <li>- First-phase of implementation will be the Ubungo and Kariakoo and will be operational by 2010; will use 145 buses and 221 feeders which will be EURO 3 diesel</li> <li>- Second phase will probably be fully implemented in 2014</li> </ul>
Surface and Marine Transport Authority (SUMATRA) <u>Delegate:</u> Mr. Anastas Selemani, General Director of Road Transport	<ul style="list-style-type: none"> <li>- Regulates daladalas: provides license and routes for operation</li> <li>- Currently, 7000 daladalas in the city</li> <li>- Looking forward to the phaseout of daladalas</li> <li>- Will terminate daladalas wherever BRT is operational; 1500 daladalas will be rerouted during first phase of DART</li> </ul>

	<ul style="list-style-type: none"> <li>- Willing to approve DART fares buying the argument that higher quality of service deserves higher costs</li> <li>- Notices the problem that the number of cars is rising in the city due to poor public transport supply</li> <li>- Imported cars are second-hand and even older</li> </ul>
<p>Energy and Water Utilities Authority (EWURA)  <u>Delegate:</u>  Eng. Shaban Seleman, Petroleum Inspector</p>	<ul style="list-style-type: none"> <li>- Regulates fuel quality and prices</li> <li>- Of the current fuel prices, CIF (Cost, Insurance and Freight) contributes for 50-52%, taxes for 33 to 37% and the channel margin for 10-11%</li> <li>- Do not use partial taxing for vehicles</li> <li>- Against higher taxing for private car commuters due to the lack of poor public transport</li> </ul>
<p>Dar es Salaam City Council  <u>Delegate:</u>  Mr. Raphael Daga, Public Relations Office</p>	<ul style="list-style-type: none"> <li>- Previously in charge of the DART project</li> <li>- Believes the population of the city has reached 4.5 million</li> </ul>
<p>National Environmental Management Council (NEMC)  <u>Delegate:</u>  Mrs. Glory Combe, Air Pollution</p>	<ul style="list-style-type: none"> <li>- Advances environmental imperatives</li> <li>- Pushes SUMATRA not to give licenses to old and highly emitting daladalas</li> <li>- Believes currently that there is need for more daladalas due to population growth</li> <li>- Believes in regulating the import of cars by heavily taxing old vehicles</li> </ul>
<p>Dar es Salaam Commuters Bus Owners Association (DARCOBOA)  <u>Delegate:</u>  Mr. Sabri Mabruk, Chairman</p>	<ul style="list-style-type: none"> <li>- Represents about 30% of the current daladala owners</li> <li>- follows up SUMATRA and voices owner's petitions</li> <li>- Aware of DART but to a very limited extent</li> <li>- Looking forward to getting involved with DART but do not understand how; hopes they will be offered shares/stock</li> <li>- Claims current fares are not economically feasible to operators</li> </ul>
<p>Sumatra Consumers Consultative Council (SCCC)  <u>Delegate:</u>  Mr. Oscar Kikoyo, Executive Secretary</p>	<ul style="list-style-type: none"> <li>- Represents the users of public transport</li> <li>- Works closely with SUMATRA in regulating daladalas</li> <li>- Urging SUMATRA since the past few months to reduce daladala fares by 25% (10% for reduction in fuel costs, 5% for negligence of operators and 5% for the disturbance causes by touts)</li> <li>- Willing to approve DART fares – better service, higher fare</li> </ul>
<p>Illala Municipal Council  <u>Delegate:</u>  Mr. Kefa Dan, Trade Department</p>	<ul style="list-style-type: none"> <li>- Regulates taxis: provides license and registration</li> <li>- Number of taxis is declining, from about 7200 in 2005 to 4000 in 2008</li> </ul>

## 5. Analysis

### 5.1.Characteristics of the Sampled Population

The gender composition within the sample groups showed relatively poor results compared to the established figures for the city. This is because more males than females answered the questionnaires. Therefore, the outcome of this study should not be misinterpreted to mean that there are more male dwellers than female dwellers (or commuters otherwise) in the city. The results on the age structure however showed relatively good representation of the population. The figures for the proportion of the people aged between 31 and 60, for example, are almost the

same showing the well representation of the population in the city. The result for people over 60 years old was lower as these people do not commute as much as the other age groups.

The age breakdown shows that the majority of commuters (98.6%) are aged between 18 and 60 years. This to some extent indicates the predominance of work trips as it represents the working age group. The dominance of the working age in the commuter system was 100% among daladala drivers and 98.2% among private car commuters. The fact that most of these commuters travel in those lines on a regular (largely daily) basis illuminates the *monocentric*<sup>12</sup> nature of the city and the concentration employment opportunities in the city center.

Further, the socio-economic and demographic data collected from the daladala drivers and car commuters reveals that driving in Dar es Salaam is highly gender skewed. All daladala drivers and 86.2% of the car commuters were male. In terms of education, roughly half of the public transport commuters and all of the daladala drivers had only secondary education and below. On the contrary, about 65% of the car commuters have had college and university studies and none of them had any formal education. This suggests a strong link between educational level and income. The link is supported by Table 3 which depicts that the median individual and family incomes of the car commuters are double and triple, respectively, that of the public transport users.

## **5.2.Public Transport Use**

The result on public transport use revealed that about 85% of the users commute at least five times a week. This regular commuting pattern upholds the argument advanced earlier that the dominating trips made are work trips. The results further show that almost all trips (95%) are made with daladalas. This suggests the need to center any passenger transportation improvement efforts in the city on daladalas. Conversely, it can be learnt here that these vehicles play a central role in the economics of the city as they transport a huge chunk of the population and facilitate employment and market opportunities. This role is particularly vital in light of the fact that Dar es Salaam generates 70% of the national revenues (Mlambo and Khayesi, 2006).

The ridership for rickshaws and taxis was found to be 4% and 2%, respectively. This can be explained by the high costs of travelling with these modes. It was observed during the field work that currently a trip with rickshaws and taxis cost as much as 15 and 30 times more, respectively, than a daladala trip. However, the high ridership with daladalas should not be interpreted as if daladala fares are cheap. As presented in the last chapter, only 2% of the public transport commuters think daladala fares are cheap whereas 78% of them claimed current fares are

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<sup>12</sup> See Schwanen *et al.* (2001)

expensive. These findings bestow the notice that transportation in Dar es Salaam can be quite a challenge for the majority of the population.

The Public transportation challenge becomes particularly apparent when looking at the results for the number of daladala people take per day as well as their reasons for taking daladala (rather than walking or cycling). It can be seen that 89% of the commuters travel with more than three daladala per day. It is not that they do not consider walking and/or cycling. But 87% of them travel to destinations that are too far to walk while 68% of them cannot afford to buy a bicycle or lack the lanes to ride them on; and the fear of traffic accidents intimidates them. During the interviews, Mrs. Asteria Mlambo of DART put this eloquently as: “*Cycling in Dar is only for daring cyclists*”<sup>13</sup>.

Public transportation in Dar can be truly challenging. It can be seen in Figure 5 that 30% of the daladala commuters use the mode only because it is the cheapest alternative they have. Conversely, 40% of them use the mode because it is their only alternative. An important analysis can also be made by looking at the percentage of people who are forced to walk for not affording a daladala trip and the frequency at which that happens to them. Figure 4 demonstrates that 33% of the public transport commuters often go through that experience while it happens sometimes to 42% of them.

The issue of the high transportation costs in the city being a major finding by itself, it was followed by another finding that it is not duly understood (or taken seriously) by some of the important transportation officials in the city. As presented in Table 6, the interviews with Mrs. Mlambo of DART, Mr. Selemani of SUMATRA and Mr. Kikoyo of SCCC gave that implication. Stating that their offices would approve DART to run on higher fares than current fares, Mr. Selemani and Mr. Kikoyo expressed their thoughts that current daladala fares are not burdensome to the dwellers of the city. Besides, they both claimed that people would be willing to pay even much more for a quality service. Yet, questioned about the ability of the people to pay those fares both parties disclosed that what they advanced was only their opinions and cannot be backed up with empirical evidence. They both witnessed that surveys have not been conducted in those lines.

Mrs. Mlambo, on the contrary, acknowledged that current daladala fares are quite expensive and that people struggle financially. Yet, she claimed that DART should not be called upon to solve that; rather it is a national issue that salaries should be raised to all citizens considering overall rise in the cost of living. The response was well-taken and case study findings were analyzed to test the validity of the argument. Thus the *travel money budget* was calculated for the sampled public transport commuters using the responses on the number of daladala taken per day, the

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<sup>13</sup> Fieldwork interviews with DART, 18 - 30 Feb. 2009

median monthly individual salary and the days of travel per week. The analysis showed that the mean travel money budget for the inhabitants of the city is 24% of their monthly individual salaries. This clearly showed the large share of transport expenses in individual salaries thereby completely refuting DART's arguments.

### 5.3. Car Commuters

The results showed that 75% of the car commuters take their cars in response to the lack of decent public transportation in the city. This finding coupled with findings from the interviews held with the city's officials suggests a strong link between the poor public transport delivery in the city and the number of private cars in the streets. The director of road transport at SUMATRA, Mr. Anastas Selemani said, for example, that commuting with daladalas is so unpleasant and unreliable and people consider owning a car is the only way out. Likewise, Mrs. Victoria Combe of NEMC and Mr. Shaban Seleman of EWURA stated that people opt for purchasing cars to escape from the poor services from daladalas.

The lack of a decent public transport system in the city has not only increased the number of private cars but also kept them completely unregulated. The interviews held with the Dar es Salaam's transport authorities uncovered that there is not it a single office that regulates their number or environmental effects<sup>14</sup>. Nothing has thus been done to limit their number. In fact, the interviews showed that actions have been on the contrary. Mr. Selemani, for example, agrees to this view and adds, "*Dar's public transport is hopeless. That is why most offices give their employees loans to purchase cars.*" Similarly, discussing introducing differential fuel prices to limit the use of private cars, Mr. Sheban of EWURA objects the view by, "*Do you want us to go on horses?*"

Looking at the car commuters that would shift to DART, the results show that it is only 4% of them who would not at all consider shifting, whereas 40% of them said that they will completely abandon their cars. However, this is only if DART runs city wide. The modal shifting will be significantly less according to the current DART's implementation plans. For the Phase I, as much as 29% of the respondents claimed that they will continue using their cars even in those lines. This implies that most of the environmental and social harms springing from private car commuting would persist for the following two decades, as DART is expected to be fully implemented by 2030 (JICA, 2008). This suggests the need for mechanisms to limit the number of cars in the city. The questionnaire responses showed, for example, that a 10% and 25% rise in fuel prices, for example, would cause 67% and 73%, respectively, of the current private car commuters to completely give up their cars or to drive only a few days week.

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<sup>14</sup> Fieldwork interviews with SUMATRA and NEMC, 18 - 30 Feb. 2009

#### 5.4. Daladala Drivers

From the interviews with SUMATRA and DART, it was found that daladalas operate in routes provided to them by SUMATRA and at a specific fare fixed to that route also by SUMATRA. With the introduction of the BRTs, the plan is to ban daladalas from operating in those lines and rerouting them to other parts of the city where BRTs have not yet started operation. This was, according to Mr. Selemani and Mrs. Mlambo, designed to systematically phase-out daladalas from Dar es Salaam by pushing them to move to neighboring towns and cities.

The findings of this study, however, depict that this will succeed only if the DART system is implemented throughout the city at once rather than the proposed implementation in phases. This is because the daladala operators would persist in operating their vehicle in Dar as long as they are provided with routes. This can clearly be seen by the result that 60% and 28% of the current operators believe that there is need for more daladalas throughout the city at all times and during peak hours only, respectively. A huge uncertainty can be pointed out here, therefore, as to how many of them would leave the city and how many would stay. With the full implementation of DART's phase I, for example, according to Mr. Selemani and Mrs. Mlambo, about 1500 daladalas will be rerouted within Dar. The findings of this case study show a high probability of most of them remaining in Dar which in turn brings about serious implications to the city in terms of emissions and pollution, etc.

Furthermore, the results of this study showed that the issue of job losses due to the introduction of DART has not been thoroughly studied. The interviews with DART agency and the DARCOBOA revealed that there is great will to involve the daladala operators in the up-coming system. However, there is not virtually any clear plan on how that will be accomplished. On one hand, Mrs. Mlambo quotes one of her colleagues as, "*Job loss is zero,*" and goes on advancing the proposal that all daladala drivers who have secondary education and above will be trained and recruited as BRT bus drivers. While, on the other hand, Mr. Sabri Mabruk, the chairman of DARCOBOA, expects that they will be provided with a distinctive opportunity to purchase shares/stock in the operations of DART. Mrs. Mlambo, however, does not acknowledge that. Rather, she states that DART will be sold out on bid to private or corporate investors who will thence control its economics; and DART will in a way be limited to inspecting the quality of service provided.

Further examining DART's plans to recruit the daladala drivers, as advanced by Mrs. Mlambo, the results of the questionnaire responses were consulted for educational levels of the daladala drivers. It was found that about 60% of them have only primary or no education that disqualifies them from being considered for recruitment. Moreover, their responses to accepting a job offer in the new system showed that about 37% of them will not do so at 130,000 TZS, the average

monthly salary in Dar es Salaam (Population & Housing Census 2002. This shows that daladala operators can be seriously affected by the ban of daladalas.

Looking at the field work findings, it is very unlikely that job loss would be zero. Yet, the number of people losing their jobs may not be significant enough to deter a decision on introducing DART. New jobs may also be created. The analysis here, therefore, should only point out the lack of transparency in the planning process and that the fate of the daladala drivers has not yet been properly handled. That's perhaps where Mr. Mabruk's concern is springing from: "*The plan should not be just to drive us out. We are not enemies of the city. We are just trying to make a living.*"

It was also found from the interviews that most of the daladala drivers are currently quite reluctant to hold meetings to discuss DART; be it amongst themselves or with the city's officials<sup>15</sup>. This, according to their responses, sprang from the long time it is taking DART to be transformed into action and the postponing of activities that followed. DART's first phase was, for example, said to be fully implemented in 2008 (ITDP in Kanyama *et al.*, 2004). Yet, with a new implementation date of 2010, its construction has not yet started<sup>16</sup>.

## 5.5.Emissions

Using the data collected in this study and previous research from the Ardhi University, vehicular emissions was estimated for Dar es Salaam. In performing this task, a top-down fuel consumption approach adapted from Meyer *et al.* (2008) was used whereby the response collected on fuel expenses was used to calculate emissions. This was combined with data on the number of different vehicles in the city and *Emission Factors* for each vehicle type. Appendix B gives details of the calculations and the references for the figures used.

The formula used to calculate emissions was:

$E = N \times FC \times EF$ , Where:

E = Total emissions from all vehicles in gm per period

N = Number of vehicles out on the street on any given day

FC = Fuel consumed per vehicle per period

EF = Emission factor of gas (g of pollutant emitted per liter of fuel)

It was assumed that of the daladalas currently operating in the city, 90% of them will be functional and on the streets on any given day. It was also assumed that 70% of the private

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<sup>15</sup> Fieldwork interviews with DARCOBOA and some daladala drivers, 18 -30 Feb. 2009

<sup>16</sup> Fieldwork interviews with DART, 18 - 30 Feb. 2009

commuter cars will be functional and on the streets on any given day. Fuel consumption per day was calculated for both daladalas and private commuter cars using the costs of 1343 TZS and 1315 TZS for petrol and diesel, respectively, based on the cap prices in the city as of February 2009 according to EWURA (2009). The emission factors for the private cars were calculated using the exhaust emission standards for Colombia from the year 1996 according to Onursal and Gautam, 1996 (in Faiz *et al.*, 1996). This was adopted because Tanzania does not have a national emission standard and thus it was believed that a standard from a developing country like Colombia would provide comparable values. The table below (Tables 7) presents the results.

**Table 7: Estimated current vehicular emissions in Dar**

Type of vehicle	No. per day	Fuel per day (lit)	Emission Factor (g/lit)			Total Emission (tons/year)		
			CO2	CO	NO	CO2	CO	NO
Daladala	6300	42	2386	532	1.8	230437	51380	174
Private car – petrol	23506	7.4	2320	23	6.2	147296	1460	394
Private car – diesel	6630	15	2664	23	6.2	96701	835	225
Total						474435	53675	793

Estimating the emissions for the years between phase I and phase II DART implementations, that are expected to be in 2010 and 2014, respectively, it was found that the number of daladalas will remain the same, if not rising, while about 145 BRT buses will be added on the corridor roughly between Ubungo and Posta<sup>17</sup>. A best case scenario was adopted, according to the case study findings that 40% of the private car commuters will completely give up their cars (in response to a good public transport system throughout Dar). The emissions of CO<sub>2</sub>, CO and NO from vehicular sources were then calculated for the year 2010. The table below (Table 8) presents the results.

**Table 8: Estimated vehicular emissions in Dar in 2010 (best case)**

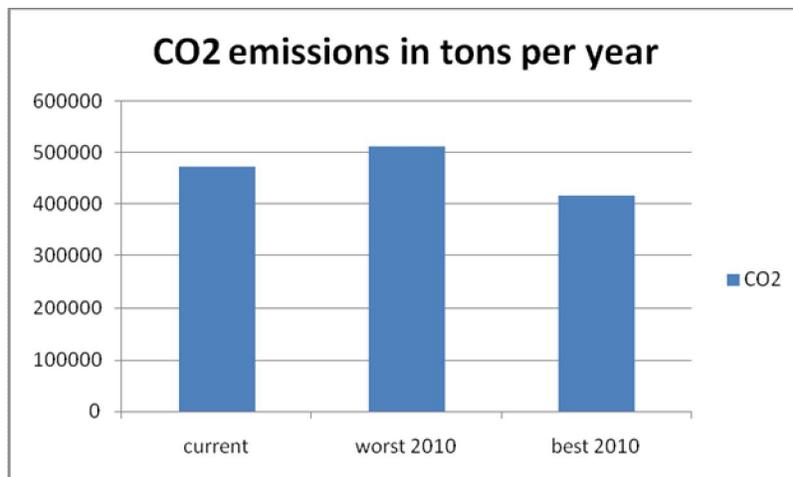
Type of vehicle	No. per day	Fuel per day (lit)	Emission Factor (gm/lit)			Total Emission (tons/year)		
			CO2	CO	NO	CO2	CO	NO
BRTs	145	281	2664	1.6	16.3	39619	24	242
Daladala	6300	42	2386	532	1.8	230437	51380	174
Private car – petrol	14103	7.4	2320	23	6.2	88374	876	236
Private car – diesel	3978	15	2664	23	6.2	58021	501	135
Total						416451	52781	787

In the worst case, which is also the *business as usual*, it was assumed that the number of vehicles does not change between now and 2010. This makes the most sense because, firstly, the number of private cars has been rising in Dar for quite some time, that makes assuming the same number between now and 2010 quite realistic. Secondly, DART's first phase of implementation puts BRTs only between Ubungo and Posta that makes it hard to estimate how that would change the

<sup>17</sup> Fieldwork interviews with DART and SUMATRA, 18 - 30 Feb. 2009

number of cars in the city. Even though 71% of the car commuters said that they would not take their car as they travel in that corridor, it is very hard to estimate how often they travel in those areas and, hence, how that changes the total number of cars in the city. Pertaining to the computations above, this generates emissions of 513125, 53905 and 1031 tons/year of CO<sub>2</sub>, CO and NO<sub>x</sub>, respectively.

It can be seen from the analysis that DART would in the best case reduce CO<sub>2</sub> emissions in the city by 12% (from 474416 to 416451 tons) as shown in the graph below (Fig. 5). It can also be seen in the same case that it will reduce CO and NO<sub>x</sub> emissions by only 1.7% and 0.7%, respectively (shown in Fig. 6 below). It can be argued from these results therefore that the introduction of DART is a transition towards a more sustainable urban mobility system but needs further development. This can be in terms of other fuel systems, etc. But also, it can be seen at least for the first few phases that its impacts in terms of emissions are greatly centered on the number of private cars that will be taken out of the streets. Coupled with the discussions in earlier sections, therefore, that suggests both the need to cut the period between BRT implementation phases and the need for mechanisms to regulate the number of cars in the city.



**Figure 5: Current CO<sub>2</sub> emissions in Dar and projections for 2010**

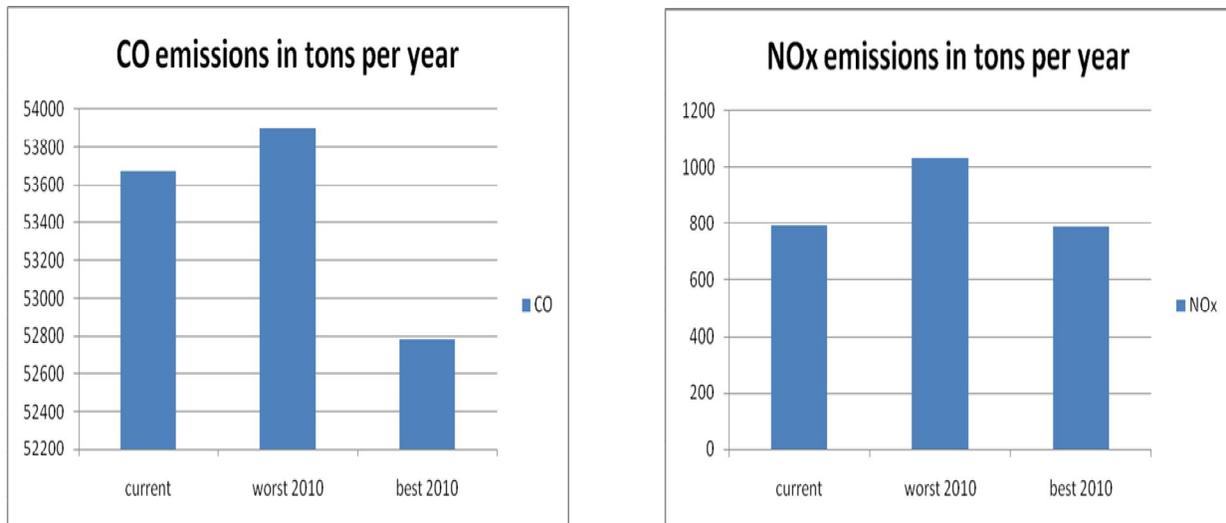


Figure 6: Current CO and NOx emissions in Dar and projections for 2010

## 6. Discussion

### 6.1. Comparative Numbers

Looking at the modal split of public transport in the city, the results of this study showed that 94.1% of the public transport commuters use daladala. This result was highly in accordance with the findings of Kanyama *et al.* (2004) who measured daladala use rates across neighborhoods in Dar. Their results showed that public transport commuters almost entirely use daladala shown by 90% at Kawe, 97% at Illala, 98% at Mbagala, 77% at Miktocheni, 96% at Kurasini and 96% at Tabata (Ibid).

Apart from that, some of the aspects explored in this study were also previously examined by other researchers<sup>18</sup> while some of them were completely new and unexplored. To my knowledge, most of the previously conducted researches focused on describing the weaknesses of the current public transport supply in the city in terms of aspects as reliability, travel time and comfort; while only a few studies tried to analyze the public transport commuting costs in the city. One study which analyzed public transportation expenditure is Olvera *et al.* (2003). The study used a 1993 national Human Resources and Development Survey and calculated the monthly travel money budget to be 10% by then (Ibid). In the article, the author argues that the method of the data collection used in the study was incompetent and has thus underestimated the expenditure on transport.

In comparison to that, the mean travel money budget for the inhabitants of Dar has been calculated in this study to be 24%. The value happens to be quite realistic based on the fact that

<sup>18</sup> Examples are Kanyama *et al.*(2004); Olvera *et al.*(2003); SSATP (2005)

Dar es Salaam is very transport dependent due to the concentration of employment and market facilities in the city center (as noted by Mrs. Combe of NEMC<sup>19</sup> and argued by Olvera *et al.*, 2003). Further, the figure is quite acceptable when compared to cities as Cotonou – the economic capital of Benin. A 1999 survey of the West African Economic and Monetary Union, UEMOA (in Olvera *et al.*, 2008), for example, showed that the travel money budget for the city is 22%, quite comparable to the finding for Dar.

Moreover, it was found in this study that 43% of the public transport commuters think current daladala fares are expensive. This was found highly in agreement with the findings of Kanyama *et al.* (2004). They collected responses on ten public transportation aspects that commuters prioritized and the reduction of daladala fares was ranked among the first five (Ibid). Further, their survey showed that of the public transport commuters in different neighborhoods 48% in Tabata, 42% in Kawe, 56% in Illala, 34% in Mbagala thought current fares are high (Ibid). Such response was low in the relatively rich neighborhoods of Mikocheni and Kurasini where responses were 18% and 17%, respectively (Ibid).

Otherwise, most of the aspects examined in this paper happen to be largely unexplored in previous research with regards to the city. This is because of the extensive nature of data collection used in this study. Questionnaire responses were collected not only from public transport commuters but also from the daladala operators and private car commuters. It can be argued that this study is quite unique in that most of the previously conducted research focused on only one group - almost entirely on the public transport commuters. Likewise, most of the research done on vehicular emissions in the city focused on describing air pollution levels in the city and plotting the link with vehicular flow. Only one research material that compares emissions before and after DART was retrieved from the Ardhi University, yet it does its calculations considering the complete replacement of daladalas with BRT buses, which made it of less value in this study.

## **6.2.Methodological Critique**

Based on the experience gained during the field work, the study could have assumed better results had questionnaires been replaced with interviews. This is basically due to the level of illiteracy and confusion observed at site. Some of the respondents had problems writing digits while others struggled even in ticking the right box. Some of these cases were noticed at spot and corrected while the responses that left the site uncorrected were excluded from data analysis. Furthermore, the data collection using questionnaires has made it difficult to get the responses from old people (with sight problems, etc).

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<sup>19</sup> Fieldwork interviews with NEMC, 18 - 30 Feb. 2009

Apart from that, respondents were quite willful to fill the questionnaires. They also did it with much care and concentration. It was observed that many of the respondents took ample time to understand every question and respond accordingly. My suspicion is that, even though an explicit introduction was put on the top of all questionnaires, many respondents thought that the questionnaires were forms they were legally required to fill. This was particularly evident within the daladala drivers. Their attentiveness has considerably given my data accuracy as plenty of them seemed to have responded to the best of their knowledge. Some respondents even wrote their contact information which in turn shows a high level of accountability on the information they have provided.

The questionnaires were in Kiswahili that enabled collecting data from all educational levels (as formal education in Tanzania is in English in secondary school and above) while also making it easy for respondents to understand the questions. Nevertheless, some of the questions to public transport commuters required answers on how often one travels, how many of a certain mode (say, buses) he/she takes, etc, that demanded average values. The respondents thus had to come up with an average that put a bit of inaccuracy in the data collected. Similarly, the daladala drivers and private car commuters had to tell their expenses on fuel and accessories. These responses also required average values that to a certain extent reduce the precision of the data collected.

Further, the responses by the private commuters to some of the questions could have been biased. Questions 2 and 3 ask whether one will consider using the up-coming system or not. There is some probability that a respondent will deduce what he/she is supposed to answer and thus respond accordingly. This could have underestimated or overestimated some of the findings. Looking at questions 5 and 6 for the public transport commuters (on the cost of public transport and whether people are forced to walk because of that), putting those questions next to each other can be criticized. Respondents can adapt the same response to question 6 as their response to question 5 so as to remain consistent.

These inherent problems being there, it can be argued that the data collected was quite realistic compared to previous research. It has also succeeded in portraying the general picture in the previously unexplored areas.

### **6.3.The Dar es Salaam Commuting System Solution in a Larger Context**

Litman (1999) argues that a “more sustainable and people-centered transport” system must among other things ensure social equity and accessibility for all. The author also argues that in most transport plans the poor are left out and thus barely benefit from improvements made (Ibid). Putting this concept in the context of Dar es Salaam, DART tends to raise the same problem. The fact that it is going to operate on fares already expensive for a great deal of the inhabitants makes

its services distributed inequitably. Inequitable distribution in such services in turn limits people from an array of market and employment opportunities thereby contributing to deepening poverty and inequalities (Greig *et al.*, 2007; SSATP, 2005; Olvera *et al.*, 2003).

For Dar es Salaam, the link between the current inequitably distributed public transport services and its consequence in the economy has already been established by SSATP (2005). The study points out that a great deal of the inhabitants are “immobilized around their homes” because they could not afford the current fares (Ibid). It has long put the problem as:

*“... a large number of residents of Dar es Salaam cannot afford the bus fare, even for a single trip. In addition, most people cannot afford to own a bicycle, which costs about four times their monthly wage. ... it is very important that the level of mobility, for the majority of the people, should be increased so that they participate in a wide range of economic activities.”*  
(SSATP, 2005, pp. 16)

The quote above may be stressing more on the economic gains of mobility which can be debated (See Whitelegg, 2003 for criticism). Nevertheless, it effectively communicates the level of economic challenges the public transport commuters in Dar go through.

I believe it is a necessary condition for DART to address the current high costs of public transportation so as to ensure sustainable transportation in the city. Although access was denied to the financial plans of the system, it is unarguable that DART should reconsider its proposed fares and endeavor to run on equitable fares. This may raise the need for its fares to be subsidized through a national tax or through any other system, which in itself unveils a whole new discussion (that is not covered in this paper). Yet, the notion that its proposed fares are inequitable remains unarguable.

Further, research shows that the number of cars is rising globally (Banister, 2005; Gururaja, 2003). Banister (2005) shows that currently only 30% of all vehicles exist in the emerging and developing countries, but over the following 25 years this number will go up to about 43% as the global number of cars increases by 75%. Indeed, these numbers can be debated. One common note concern, for example, is that soaring global fuel prices will exclude developing countries further, thereby limiting the rise in the number of cars. It needs to be clearly put, however, that any possible rise in the number of cars will have serious implications towards global fuel consumption as well as the emission of CO<sub>2</sub> and other pollutants.

Pertaining to these trends, although specific data could not be found, the case of Dar es Salaam presented similar evidence. As was explained in earlier sections, this tends to have sprung predominantly from the poor public transport conditions in the city but also the lack of any mechanism to limit commuting with private cars. The analysis reveals that driving in Dar has not

internalized the environmental and social costs (as green house gas and other pollutant emissions, traffic accidents, noise pollution, etc). This has in turn made driving readily available to many<sup>20</sup>. It can be argued, therefore, that there is a need to introduce some differential mechanisms (be it taxing private cars differently during importation or their fuels in town, or other) to limit the number of cars. I strongly believe that this would push a considerable number of private car commuters into travelling with DART.

The need to limit the number of private cars in Dar also springs from the observed fact that the city is *monocentric*<sup>21</sup> in the distribution of offices, market, etc. It has also been observed that this nature of the city has coupled with rapid urbanization and population growth and caused heavy congestion in most of its major streets (JICA, 2008; Olvera *et al.*, 2003; NEMC, 2009; NBS, 2006). Besides a planning solution to distribute opportunities and services across the city, this also emphasizes the need to act in limiting the number of cars. Banister (2005) effectively communicates the problems with more and more cars in developing country as:

*“...city roads in developing countries are more congested at lower levels of car ownership. Slow moving traffic and ill maintained vehicles cause greater levels of pollution than that experienced from more efficient modern vehicles operating in less congested conditions.”*  
(Banister, 2005, pp. 14)

The quote from Banister (2005) above may sound as if it is the lack of roads which is the source of the congestion in cities like Dar es Salaam. And based on that, it can lead to the argument that providing sufficient roads will make an end to the problem. Nevertheless, even though roads are important elements of sustainable mobility, they cannot be solutions by themselves. In fact, their effect is far from that: they increase the severity of the problem. Hopwood (1999), for example, uses examples from London to arrive at, *“The simplistic answer to traffic jams is to build more roads. More roads do not reduce congestion, however, but encourage traffic.”* Likewise, Whitelegg (2003) states that many incidents have proved that sustainable mobility efforts centered on expanding infrastructures – which he calls *predict-and-provide* – end in failures; and he thus suggests their replacement with *predict-and-prevent* efforts as alternative planning solutions and behavioral change.

The analysis of the case study findings further showed that there is a communication gap between DART and the daladala operators with regards to their fates. This reveals not only the lack of awareness about the proposed system among daladala operators but also a deficiency of institutional coordination in the planning process. That is, DART has fallen to the pitfall of the lack of transparency and accountability within planning authorities in the city which was pointed out by Calsson-Kanyama *et al.*, (2006). It has propagated the inadequate stakeholder dialogue

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<sup>20</sup> SeeGTZ (2007)

<sup>21</sup> See Schwanen *et al.* (2001)

that long existed in the city due to, among other things, institutional deficiency and “outdated and vague” laws that govern planning, as argued in the report (Ibid). This is a major feature of unsustainable transport planning when viewed through the definition outlined earlier by Transport Canada (2001) (in Jeon and Amekduzi, 2005). The current lack of interest among daladala drivers to meet and discuss DART also highlights this drawback.

Finally, DART would obviously improve the public transport conditions in Dar es Salaam over a short- and medium-term time perspective. When fully implemented, it would hopefully alleviate the currently disorganized passenger transport delivery by daladalas which is also characterized by: lack professionalism and safety, lack of reliability, long travel times, overloading of passengers, poor sitting and standing conditions, etc (Kanyama *et al.*, 2004; JICA, 2008). It is thus indisputable that it will modernize the public transport system in the city. It can clearly be seen here therefore that DART can, like almost all BRT systems elsewhere, be a quite rewarding development project.

Nevertheless, it can be pointed out – based on the sustainable transport imperatives discussed in previous sections – that there are many conditions that need to be closely examined to make the project a sustainability project. If quickly checked with the United Nations Habitat II guidelines for sustainable transport and communication systems, for example, DART would clearly come short of an exemplary system as it, among other things, does not target to favor constrained population groups and for its use of diesel (UN Habitat, 1996b). This is therefore to challenge a common note understanding that having a BRT system (or any other system) could bring about a sustainable transport system by itself; rather its economic, social and environmental impacts be scrutinized using an interdisciplinary approach. It is also to underline the need of surveys to see what is on ground before adopting theoretical facts.

## **7. Conclusion and Recommendations**

It can be concluded from this study that the introduction of a BRT system in Dar es Salaam has numerous evident gains in terms of improving the current public transport supply. Nevertheless, some shortcomings have been identified that limit the contribution of the system in its endeavor towards creating a sustainable urban mobility system in the city. These shortcomings are the inequitable distribution of services across population groups; the need to limit the growth in the number of cars; the lack of involvement of the current public transport operators in the planning process and the heedless handling of their fates. Targeting enriching the planning of the proposed system, this paper empirically shows that these loopholes need to be filled.

Thus the main recommendations of the study are:

1. There is a need to adopt an equitable fare affordable to as much of the different population groups as possible. That in turn demands duly understanding the financial performance of the new system early at this stage and accordingly considering acquisition of subsidies (or designing any other mechanism) that can be put out to all users or only to certain population groups
2. There is a need to form or assign an authority that regulates the rising number of cars in the city so that mechanisms be introduced that induce modal shift from car commuting to the use of public transport.
3. There is a need to raise the awareness of the current public operators about the DART project and the anticipated future of Dar so as to involve them in the planning process. This in turn demands enhanced precision and accountability from DART in planning and public communications.

## 8. References

- Archer, M.S. & J.Q. Tritter. (2000). *Rational Choice Theory: Resisting Colonization*. Routledge.
- Banister, D. (2005). *Unsustainable Transport: City Transport in the New Century*. Routledge - Taylor & Francis Group.
- Barrios, S., L. Bertinelli & E., Strobl. (2006). Climate Change and Rural-Urban Migration: The Case of Sub-Saharan Africa. *Journal of Urban Economics*, 60, 215-218.
- Black, W. (2000). Socio-Economic Barriers to Sustainable Transport. *Journal of Transport Geography*, 8, 141- 147.
- Bryman, A. (2004). *Social Research Methods*. Oxford: Oxford University Press.
- Bundala, M. (2004). *Estimation of Motor Vehicle Fuel Consumption and the Corresponding Greenhouse Gas Emissions in a Developing Country Cities*. Unpublished. University of Dar es Salaam.
- Button, K. & P. Nijkamp (1997). Social Change and Sustainable Transport. *Journal of Transportation Geography*, 5 (3), 215-218.
- Dar es Salaam City Council. 2007. *Consultancy Services for the Conceptual Design of a Long term Integrated Dar es Salaam BRT System and Detailed Design for the Initial Corridor: Environmental and Social Impact Assessment (EISA)*. United Republic of Tanzania.
- EWURA, Energy and Water Utilities Regulatory Agency. (2009). Public Notice on Indicative and Cap Prices for Petroleum in the Country Effective 24<sup>th</sup> February 2009. REF: PPR/02-4/09. EWURA. Tanzania.
- Faiz, A., C.S. Weaver & M.P. Walsh. (1996). *Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions*. World Bank.
- Gonçalves, G. A., T.L. Farias and C. M. Silva. (2005). Comparison of Diesel and Natural Gas Urban Buses Energy Efficiency and Environmental Performance. *Eighth International Conference on Technologies and Combustion for a Clean Environment*. Clean Air. Lisbon, Portugal. Available on: [http://dtea.ist.utl.pt/pdf/publicacoes/papers/Goncalves\\_Farias\\_Silva\\_Comparison\\_Diesel\\_Natural\\_Gas.pdf](http://dtea.ist.utl.pt/pdf/publicacoes/papers/Goncalves_Farias_Silva_Comparison_Diesel_Natural_Gas.pdf) . Accessed on 24 may 2009.
- Green, L.G. (2002). *Rational Choice Theory: An Overview*. Prepared for the Baylor University Faculty Development Seminar. Baylor University, TX, USA.
- Greig A., D. Hulme, & M. Turner. (2007). *Challenging Global Inequality: Development Theory and Practice in the 21st Century*. Palgrave Macmillan.

Gudmundsson, H. (2004). Making Concepts Matter: Sustainable Mobility and Indicator Systems in Transport Policy. *International Social Science Journal*, 55 (1766), 199-217.

Gudmundsson, H. and M. Hojer. (1996). Sustainable Transport Principles and Their Implications in for Transport. *Ecological Economics*, 19, 269-282.

Gururaja, J. (2003). *Energy for Sustainable Development: Review of National and International Energy Policies*. Natural Resources Forum, 27, 57-67.

GTZ, German Technical Cooperation. (2007). *International Fuel Prices 2007: 5<sup>th</sup> Edition - More than 170 Countries*. Available on: <http://www.gtz.de/de/dokumente/en-international-fuelprices-part1-2007.pdf> . Accessed on 19 May 2009.

Habitat, United Nations Center for Human Settlements. (1996a). *An Urbanizing World: Global Report on Human Settlements*. Oxford University Press, Oxford.

Habitat, United Nations Center for Human Settlements. (1996b). *Istanbul Declaration on Human Settlements*. Available on: <http://ww2.unhabitat.org/declarations/ch-4c-7.htm> . Accessed on 3 May 2009.

Hall, F. (2004). Effectiveness of Participatory Planning on Urban Transportation in Dar es Salaam, Tanzania. Proceeding . *Cooperation for Urban Mobility in the Developing World (CODATU) 10<sup>th</sup> Conference*. Bucharest, Rumania. Available on: <http://www.codatu.org/francais/publications/actes/conferences/codatu11/Papers/halla.pdf> . Accessed on 19 May 2009.

Hopwood, B. (1999). Transport Policy After Paddington. *Socialism Today*, 43. Available on: <http://www.socialismtoday.org/43/globalwarning43.html> . Accessed on 20 May 2009.

Household Budget Survey. (2000/01). National Bureau of Statistics Tanzania. Available on: <http://www.nbs.go.tz/HBS/index2.htm> . Accessed on 24 Mar. 2009.

ITDP, Institute for Transportation and Development Policy. (2007). *Dar es Salaam BRT*. Available on: [http://www.itdp.org/index.php/projects/detail/dar\\_es\\_salaam\\_brt/](http://www.itdp.org/index.php/projects/detail/dar_es_salaam_brt/). Accessed on 26 Jan. 2009.

Jeon, M.C., and Amekudzi, A. (2005). Addressing Sustainability in Transportation Systems: Definitions, Indicators, and Metrics. *Journal of Infrastructure System*, 10 (1061), 31-50.

JICA, Japan International Cooperation Agency. (2008). *Dar es Salaam Transport Policy and System Development Master Plan*. Technical Report. Pacific Consultants International.

Kanyama, A., A. Carlsson-Kanyama, A. Linden & J. Lupala. (2004). *Public Transport in Dar es Salaam, Tanzania. Institutional Challenges and Opportunitites for a Sustainable*

- Transportation System*. Institutionen för Miljöstrategiska Studier. Stockholm. Sweden.
- Litman, T. (1999). *Transportation Cost Analysis for Sustainability*. Victoria Transport Policy Institute. Victoria, BC, Canada.
- Lupala, J. (2002). *Urban Types in Rapidly Urbanizing Cities: Analysis of Formal and Informal Settlements in Dar-es-salaam, Tanzania*. Stockholm Royal Institute of Technology.
- Meyer, P., F. Maes & A. Volckaert. (2008). Emissions from International Shipping in the Belgian part of the North Sea and the Belgian Seaports. *Atmospheric Environment*, 42, 196–206.
- Mlambo, A & M. Khayesi. (2006). Successful African City: Dar es Salaam – Tanzania. *Velo Mondial Conference Proceeding Plenary 6*. Available on: <http://www.africanagenda.com/velomondial2006.com/pdf/Asteria%20Mlambo.pdf> . Accessed on 6 May 2009.
- NBS (National Bureau of Statistics). (2006). *Analytical Report*. Volume X. Ministry of Planning, Economic and Empowerment. Government of Tanzania.
- OECD, Organization for Economic Cooperation and Development. (2000). *Synthesis Report of the OECD project on Environmentally Sustainable Transport*. Presented on the International Conference 4th to 6th October 2000 in Vienna, Austria.
- Olvera, L., D. Plat & P. Pochet. (2003). Transportation conditions and access to services in a context of urban sprawl and deregulation: The case of Dar es Salaam. *Transport Policy*, 10, 287-298.
- Olvera, L., D. Plat & P. Pochet. (2008). Household Transport Expenditure in Sub-Saharan African Cities: Measurement and Analysis. *Journal of Transport Geography*, 16, 1-13.
- Population and Housing Survey. (2002). National Bureau of Statistics Tanzania. Available on: [http://www.nbs.go.tz/indicators\\_2.htm](http://www.nbs.go.tz/indicators_2.htm) . Accessed on 24 Mar. 2009.
- Posner, E.A. (2002). *Law and Social Norms*. Harvard University Press. USA.
- Schwanen, T., F.M. Dieleman, & M. Dijst. (2001). Travel Behavior in Dutch Monocentric and Polycentric Urban Systems. *Journal of Transport Geography*, 9, 173-186.
- Scott, J. (2000). *Understanding Contemporary Society: Theories of the Present*. Sage Publications. Available on: <http://privatewww.essex.ac.uk/~scottj/socscot7.htm> . Accessed on 18 May 2009.
- SSATP, Sub-Saharan Africa Transport Policy. (2005). *Non-motorized transport in African cities. Lessons from experience in Kenya and Tanzania*. SSATP Working Paper No. 80. World Bank.

UNFPA, The United Nation Population Fund. (2004). *State of the World Population 2004*. The United Nation Population Fund. New York.

UNFPA, The United Nation Population Fund. (2007). *State of the World Population 2007: Unleashing the Potential of Urban Growth*. The United Nation Population Fund. New York.

US EPA, United States Environmental Protection Agency. (2005). *Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel*. Available on: <http://epa.gov/otaq/climate/420f05001.pdf> . Accessed on 20 Apr. 2009.

Vanberg, V.J. (2008). Rational Choice and Microeconomics: On the Economics of Moral Preferences. *American Journal of Economics and Sociology*, 67 (4), 605 -628.

Whitehand, J., & J. Larkham. (1992). *Urban Landscapes: International Perspectives*. Routledge.

Whitelegg, J. (2003). *Selected International Transport Investment and Funding Frameworks and Outcomes*. Final Report. Australian National Transport Secretariat. Available on: <http://www.eco-logica.co.uk/pdf/australia.pdf> Accessed on 20 May 2009.

World Commission on Environment and Development, WCED (1987). *Our Common Future*. Report of the World Commission on Environment and Development. UN Documents Cooperation Circles. New York.

WUP, World Urbanization Prospects. (2005). *World Urbanization Prospects: The 2005 Revision. Executive Summary Fact Sheets Data Tables*. United Nations, New York.

Yin, R. (2003). *Case Study Research: Design and Methods*. Sage. London.

## 9. Appendices

### A: Questionnaires

#### Questionnaire to Public Transport Commuters

My name is Merahi Ahferom. I am a Master student in Environmental Studies and Sustainability Science. I am writing my thesis about the public transport conditions in Dar es Salaam, Tanzania. I therefore kindly request your response on the following questions. Thank you!

1. What is the most common means of public transport you use?

- dala-dala       taxi       rickshaw

What is the reason for that? Because it is:

- the cheapest       the most accessible       the most comfortable       the only alternative  
 don't know

Why don't you walk?  destination is far     risk of accident     other\_\_\_\_\_

Why don't you cycle?  can't afford to buy one     no bicycle lanes     other\_\_\_\_\_

2. How often do you use public transport per week?

- everyday     2 to 3 times       4 to 6 times       don't know

3. How many of the public transport mode do you take as you ravel one way?

- one       two       three       more than three       don't know

4. What distance do you commute per day?

- below 5 km     5 to 15 km     15 to 30 km     more than 30 km     don't know

5. What is your opinion on the fare of dala-dalas?

- Very expensive     expensive     moderate     cheap     Very cheap     don't know

6. Have you ever been forced to walk because you run out of money to pay dala-dalas?

- Yes, happens often       Yes, once in a while       No, never       don't know

7. How much more than the current daladala fare do you think you are able to afford?

- 50 TZS more       yes     no;      150 TZS  yes  no  
100 TZS more       yes     no;      200TZS  yes  no

8. Age       below 18     18 to 30     30 to 60     above 60     don't know

9. Sex       male       female

10. Educational level     no education     primary     secondary     college     university

11. What is your average total monthly income? \_\_\_\_\_ Tsh  
 How many siblings do you have? \_\_\_\_\_  
 What is the average total monthly income of your family? \_\_\_\_\_ Tsh

### Questionnaire to Daladala Drivers

My name is Merahi Ahferom. I am a Master student in Environmental Studies and Sustainability Science. I am writing my thesis about the public transport conditions in Dar es Salaam, Tanzania. I therefore kindly request your response on the following questions. Thank you!

1. Do you own the dala-dala?  yes  no, I'm employed  
 If yes,  
 Imagine a new public transport that covers the whole of Dar es Salaam is implemented and dala-dalas are not allowed to operate, what will you do with your dala-dala?  
 I will leave the city and move upcountry  
 I will sell my dala-dala upcountry bus still reside here  don't know  
 If no,  
 Imagine a new public transport that covers the whole of Dar es Salaam is implemented and dala-dalas are not allowed to operate, what do you think the owner of the dala-dala do?  
 He/She will leave the city and move upcountry  
 He/She will sell his/her dala-dala upcountry bus still reside here  don't know
2. Would you accept an offer from the Tanzanian government to work as a full time bus driver in the new public transport buses at a monthly salary of 130,000 TZS?  
 yes, any time  
 yes, only if dala-dalas are not allowed to operate  no, I won't  don't know
3. Do you think more dala-dalas are needed to satisfy the transport demand in the routes other than the route between Posta and Ubungo?  
 yes, throughout the day  yes, only in peak hours  no, no need  don't know
4. What is your highest educational level?  
 none  primary school  secondary school  college  university
5. How much do you spend on fuel per day? \_\_\_\_\_ TZS, per week? \_\_\_\_\_ TZS
6. How much do you spend on oils per day? \_\_\_\_\_ TZS, per week? \_\_\_\_\_ TZS
7. How much do you spend on maintenance per month? \_\_\_\_\_ TZS
8. What is your average monthly income? \_\_\_\_\_ TZS  
 How many siblings do you have? \_\_\_\_\_  
 What is the average total monthly income of your family? \_\_\_\_\_ TZS
9. Your age:  below 18  18 to 30  30 to 60  above 60  don't know

10. Your sex:  male  female

### Questionnaire to Private Car Commuters

My name is Merahi Ahferom. I am a Master student in Environmental Studies and Sustainability Science. I am writing my thesis about the public transport conditions in Dar es Salaam, Tanzania. I therefore kindly request your response on the following questions. Thank you!

1. What is the main reason for you to drive your car in Dar es Salaam?  
 Bad public transport  need for highest accessibility  because it is inexpensive  
 to keep my social status  don't know
2. If there was a comfortable, fast and reliable public transport system **throughout** Dar es Salaam, would you have commuted on it?  
 yes, all the time  yes, most times  yes, at times  no, probably not  don't know
3. If there was a comfortable, fast and reliable public transport system **only between** Posta and Ubungu areas, would you still take your car as you travel in those lines?  
 yes  no  don't know  
How about as you travel in the other lines?  yes  no  don't know
4. How much do you spend on fuel per day \_\_\_\_\_TZS, per week \_\_\_\_\_TZS.
5. How much do you spend on oils per day \_\_\_\_\_TZS, per week \_\_\_\_\_TZS.
6. How much do you spend on maintenances per month \_\_\_\_\_ TZS
7. How much do you spend on parking per day \_\_\_\_\_TZS, per week \_\_\_\_\_ TZS
8. Will you still drive if,  
gasoline costs 1650 TZS per liter and diesel costs 1500 TZS per liter:  
 yes, throughout the week  yes but a few days in a week  no, I won't drive  don't know  
gasoline costs 1875 TZS per liter and diesel costs 1715 TZS per liter:  
 yes, throughout the week  yes but a few days in a week  no, I won't drive  don't know  
gasoline costs 2250 TZS per liter and diesel costs 2060 TZS per liter:  
 yes, throughout the week  yes but a few days in a week  no, I won't drive  don't know  
gasoline costs 3000 TZS per liter and diesel costs 2750 TZS per liter:  
 yes, throughout the week  yes but a few days in a week  no, I won't drive  don't know
9. What kind of fuel does your car run on?  gasoline  diesel  don't know
10. How many liters of fuel does your car consume per km? \_\_\_\_\_ liters
11. On average, for how long do you drive per day: \_\_\_\_\_minutes/hours, per week \_\_\_\_\_minutes/hours
12. Which lines do you drive most?  city center  peripheries  don't know
13. Your sex:  male  female

14. Your age:         below 18         18 to 30         30 to 60         above 60         don't know
15. Your educational level:     none     primary school     secondary school     college  
 university
16. What is your average monthly income? \_\_\_\_\_ TZS  
How many siblings do you have? \_\_\_\_\_  
What is the average total monthly income of your family? \_\_\_\_\_ TZS

## B: Emissions Computations

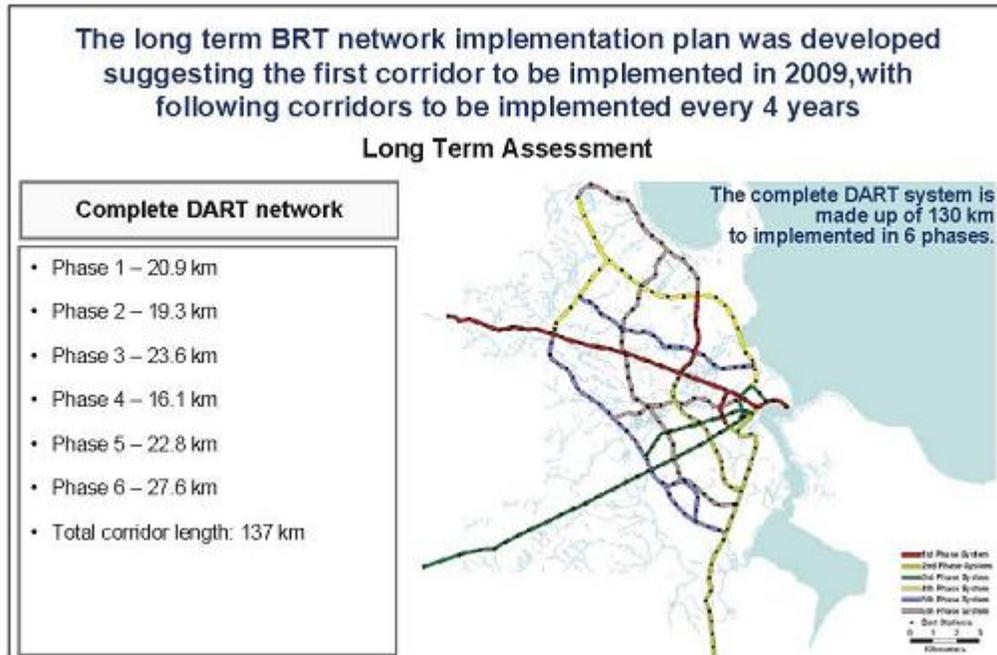
Note: The year 2009 TRA, DART, SUMATRA and EWURA references refer to the fieldwork findings of this study from interviews held between 18 -30 Feb. 2009.

1. No. of vehicles
  - Current number of daladalas in the city: 7000 (SUMATRA, 2009)  
No. of daladalas on street at any time any day = 90% (assumed) x 7000 = 6300
  - Number of BRT buses to be operating on “trunk” on phase one = 145 (DART, 2009)
  - Number of Private Cars today = 25,600 (TRA, 2009)  
Number of Petrol Powered = 78% (according to case study findings) x 10,000 = 19,968  
Number of Diesel Powered = 22% (according to case study findings) x 10,000 = 5,632
  - Number of Private cars 2010 = 29% (according to case study findings) x 10,000 = 7,424  
Number of Petrol Powered = 78% (adapting current ratios) x 25600 = 5791  
Number of Diesel Powered = 22% (adapting current ratios) x 25600 = 1633
2. Fuel consumed per day
  - Daladalas: Expenditure on fuel per day / cost of diesel per liter  
= 55,000 TZS (according to Table 6) / 1315 TZS/lit (EWURA, 2009) = 42 lit
  - BRTs: fuel economy / km travelled per day  
= 0.67 lit/km (according to Goncalves *et al.*, 2005) x 420 km (42 km trunk in phase I according to Dar es Salaam City Council 2007 and assuming 10 trips a day) = 281 lit
  - Private Cars: Expenditure on fuel per day / cost of fuel per liter  
Petrol powered = 10,000 TZS (Table 5) / 1343 TZS/lit (EWURA, 2009) = 7.4 lit  
Diesel powered = 20,000 TZS (Table 5) / 1315 TZS/lit (EWURA, 2009) = 15 lit
3. Emission Factors
  - Daladalas: established by Bundala (2004)
  - BRTs  
For CO<sub>2</sub> = a liter of diesel x oxidation factor x fuel density x kg of CO<sub>2</sub>  
= 1 lit x 0.99 (US EPA, 2005) x 734 g/lit x 44/12 = 2664 g/lit  
For CO and NO<sub>x</sub>  
= Euro III emissions / fuel economy (both values according to Goncalves *et al.*, 2005)  
= 1.10 g/km / 0.67 lit/km = 1.6 for CO & 10.98/0.67 = 16.4 for Nox
  - Private cars: emission rates (adapted from exhaust standards for Colombia based on Onursal and Gautam (1996) (in Faiz *et al.*, 1996) x fuel economy  
Emission factor for CO = 2.3 g/km x 10 km/lit (Table 5) = 23 g/lit  
Emission factor for NO<sub>x</sub> = 0.62 g/km x 10 km/lit (Table 5) = 6.2 g/lit

Emission factor for CO<sub>2</sub> (Petrol) = lit x 639 g/lit x 0.99 (both from US EPA, 2005) x 44/12 = 2320 g/lit

Emission factor for CO<sub>2</sub> (Diesel) = 1 lit x 734 g/lit x 0.99 (both from EPA, 2005) x 44/12 = 2664 g/lit

### C: Completed Route Map of DART by 2030



**Figure 7: Completed Route Map of DART**

Source: LOGIT/ITDP in JICA, 2008