# Sustainable transport system: Mobility and Accessibility in Addis Ababa




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# SUSTAINABLE TRANSPORT SYSTEM: MOBILITY AND ACCESSIBILITY IN ADDIS ABABA

Environmental and Infrastructure Planning Master thesis

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*August, 2011*

***Key words:*** *Transportation, Sustainability, sustainable transport system, sustainable development, accessibility and mobility*

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## Acknowledgement

*I would like to thank my supervisor, Prof. dr. ir. Paul Ike, for his continuous support, comments and guidance throughout this research work. Really without his significant advices, constructive guidance and encouragement it would be hard to accomplish this work.*

*I would like to thank also experts in Addis Ababa for their professional assistance, both in terms of literature material as well as several consultations. Especially I am very much grateful to Asfaw Masresha for his tireless support and encouragement throughout this research processes.*

*And finally, I thank all stuffs of Faculty of spatial sciences who had contributed in one way or another to success of my overall study and this research in particular.*

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## *Abbreviations*

| | |
|---|---|
| CST | Canadian Centre for Sustainable Transportation |
| CSA | Central Statistics Authority |
| ETB | Ethiopian currency unit (US $ 1.00 = Birr 27) |
| NEPAD | New partnerships for Africa's development |
| OECD | Organization for economic development and cooperation |
| ORAMP | Office for revision of Addis Ababa master plan |
| SSATP | Sub-Saharan African transport policy program |
| WCED- | World commission for economic development |

# ABSTRACT

An organism's circulatory system that passes nutrients (such as amino acids, electrolytes and lymph etc), gases, hormones, and blood cells, functioning is very crucial for health to sustain or life to exist. If one or more, of these systems face any difficulties the overall health of that organism will be affected significantly. In the same way urban road network serve as a circulatory system for livable cities within which different parts of the cities are interdependent. However, in cities like Addis Ababa transport systems functions in haphazard fashion. Some parts of the city have relatively better public transport services, the other parts may have better service distribution, peripheries and slums/inner city/ lacks both and quality transport infrastructures, some routes of the city are highly susceptible to traffic accident, congestion etc. Therefore, it is not possible to see healthy and sustainable transport system and which in turn have significant negative effect on overall socio-economic activities and result in environmental problems.

This study investigates critical transport sustainability issues more focusing on the case study city, Addis Ababa. The state of art of interpretation towards sustainability, sustainable transport system /development/, mobility, and accessibility was discussed. Moreover, the parameters or performance indicators of sustainable transport system are used to evaluate a transport system function, whether it is sustainable or not, based on their role to achieve broad economic, social, and environmental goals of the city. The main factors which could affect sustainable transport systems in Addis Ababa are identified. The study assessed the situation how currently transport system in Addis Ababa is functioning and core problems were also dealt in detail. The risk areas are identified and finally possible strategies to combat those risks are also forwarded.

The main findings of the study are: in Addis Ababa there is disorganized and unsustainable public transport service, inadequate road transport infrastructures, and lack of effective traffic management, very limited transport mode choice and prevalence of environmentally unfriendly transport practice which all together complicates the city's mobility characteristics especially for marginalized groups (e.g. urban poor).

The overall study result indicate that Addis Ababa's current transport system is neither sustainable nor exactly towards the direction of transport sustainability in most aspects. Moreover, it is safe to say that, the current situation is far more to reach sustainability according to evaluation result of performance indicators. Furthermore, there is no single absolute way (or mechanism) to achieve sustainable transport system in Addis Ababa due to its complex current situations and comprehensiveness of sustainability notion itself. However, most agree that in general balancing economic, social and environmental goals in an effort of sustainable transport system development is crucial and best option. Effective transport system has great impact on overall urban development, and on the other hand, its sustainability could be influenced by other sectors too.

This study forwarded some basic recommendations as a solution for Addis Ababa's transport problems and it may support government efforts in transport sustainability issues. Accessibility focused transport planning, encouraging environmentally friendly transport modes, promoting public private partnership, developing an alternative mass transportation are the recommended strategies. The study also reminds that implementation of a plan is more challenging and thus further research should be done to realize the recommendations. If due attention given and further improvement done on unforeseen gaps of this research, its results will help the city government to formulate sustainable transport policies for Addis Ababa.

## *1.0. INTRODUCTION*

The world urban population is expected nearly to double by 2050, increasing from 3.3 billion in 2007 to 6.4 billion in 2050. In other words, by mid-century the world urban population will likely be the same size (6.4billion) as the world's total population in 2004. Virtually all of the world's population growth will be absorbed by the urban areas of the less developed regions, whose population is projected to increase from 2.4 billion in 2007 to 5.3 billion in 2050 (United Nations Economic & Social Affairs, 2007). According to this report over the coming decades, the level of urbanization is expected to increase in all major areas of the developing world, with Africa and Asia urbanizing more rapidly than the rest.

Moreover, all these mentioned and expected dramatic future urban population size increase will demand for different means of transportation and various social services in an urban areas. At the same time, the economic and social benefits of mobility are frequently accompanied by negative side effects; such as congestion, social exclusion, accidents, air pollution and energy consumptions. On the other hand, enhancing sustainable transportation strategies in short period of time in developing countries like Ethiopia will be one of the major challenging issues due to several economic and social realities. The policy measure on modal shift towards more environmentally friendly modes of transportations (promotion of walking, and bicycle use and development of new transport hierarchy) by using different enforcement measures and techniques to develop less car using habit of residents needs strong and comprehensive policy direction.

In conventional transport planning; facilitating mobility to make travel time as possible as short were the basic focuses, however current dilemmas on mobility becomes; that of reasonable travel time, rather than travel time minimisation. Reliability of the transport system for customers to reach their destination on time with in pre-planned period of time is becoming more crucial concern. Furthermore, in terms of cost; government and other stakeholders are spending significant amount of millions of dollars per year to increase mobility and accessibility; like by constructing different alternative routes/roads and developing different inter-urban rail ways, air ways, metro and subsidising public transport sector, etc are some of dominant transport related measures taken currently at different corner of the world. But yet travel demand of people and goods could not be bridged by only supply side measures and which in turn calls for more sustainable mobility and accessibility notions. And thus, to have clear view on what sustainability mean, and how to evaluate whether a transport system is sustainable or not? Theoretical knowledge's were briefed and summarized in section 2.4 reviewing different recent transport systems' accessibility/mobility studies.

## *1.1. Background of the study area*

Addis Ababa is the capital and largest city of Ethiopia, geographically found in the center of the country on a plateau more than 2,440 m (8,000 ft) above sea level and with the total population size of about 3 million (Ethiopian population and housing census, 2007) population projection. The African Union (AU) and the UN Economic Commission on Africa are headquartered in Addis Ababa, which all hosts numerous international conferences and various meetings. The jurisdictional area of the city is approximately 530.14 square kilometers and the city is getting sprawled at the moment in a faster rate than ever. The city is subdivided in to 10 sub-cities for the sake of decentralized urban governance.

Concerning public transportations currently there are public owned city buses called "Anbessa buses", 'Higer' buses, minibuses and small taxis are providing public transport services. The city's transport services in its current state severely affected and overloaded due to its population growth, high rural to urban migration, increase of satellite towns around the city, without significant change in supply side and service rendering. The number of people demanding public transport service per day vis-vis supplied mass transportation services in Addis Ababa without any doubt has a wide gap. And this gap in turn has significant negative impact on mobility and overall accessibility for different services.

## *1.2. Statement of the problems*

One of the major and complex problems of city of Addis Ababa is lack of efficient mobility and accesses to transport services. Inefficient urban mobility and accessibility problems are highly linked with overall functions of various components/elements of the Addis Ababa transport systems such as traffic management, transport infrastructure and transport systems.

Road transport network of Addis Ababa in most parts of the city is characterized by poorly maintained roads, streets and sidewalks coupled with occupation of pedestrian way by economic and human activities, subsequent use of vehicle lanes by pedestrians for walking, mounting buses, and taxis.

Concerning surfacing of the road; out of the total road network a small proportion of roads and streets have hard paving or asphalt. Due to the topography (a steep hill in some of the city), unplanned and uncontrolled growth of the city, limited capacity of bus enterprise; significant part of the city of Addis Ababa are still without coverage by public transport network. These include slums and shanty quarters but also blocks with permanent housing and other facilities too. However, some of these roads do not actually have any useful links to the other existing road network, and thus carry only little traffic. In general urban traffic of Addis Ababa is characterised by features that are common to many metropolitan cities of developing world, to mention only some of these features:

- Small number of cars relative to the population, but with great traffic accident record, disorganised traffic management
- High travel trips due to poor spatial distribution of various services
- Limited number of buses running on lanes (great number of minibus)
- Lack of facilities for environmentally friendly alternative mode of transports and mass transport options
- Relatively large number of small size private taxis, pick-ups and mini buses
- Negligible number of bicycles, motorcycles and all roads have no separate bike ways
- Significant number of pack animals on some routes
- Poor road network, congestion, pollution, pedestrian difficulty to use walkways especially serious problem for handicapped, aged, children etc, inadequate public bus and taxi stations

It's also worth to mention ever increasing horizontal expansion or urban sprawl vis-vis increasing demand for public transportation at each corner of the city, population (customers) growth and limited number of public buses and lack of other means of transportations (e.g. light rail system), less attention towards promoting cycling and walking in Addis Ababa are far more known problems. This study henceforth will

elaborate the existing realities of the Addis Ababa transport system with a general objective of providing solutions and suggesting measures that should be taken to make it more accessible and to enhance sustainable mobility notions.

## *1.3. Research objectives and research questions*

The /main objective/ of this research is to investigate possible techniques and approaches that could have a significant role in path way towards sustainable transport system development.

The /Specific objectives/ described as follows:

- To describe sustainable transport systems' accessibility/mobility notions
- To assess factors that affecting sustainable transport systems' accessibility/mobility in Addis Ababaa
- To examine different possible ways on how to achieve or improve sustainable transport systems' accessibility/mobility
- To forward some recommendations or solutions which may help in improving current transport accessibility problems

The overall research processes will focus on answering the following /research questions/

- What is sustainable transport systems' accessibility/mobility?
- What are the main factors which could affect sustainable transport systems' accessibility/ mobility in Addis Ababa?
- What is the situation in Addis Ababa in relationship with sustainable transport systems' accessibility/mobility?
- What possible measures must be taken to improve transport accessibility/mobility in Addis Ababa?

## *1.4. Research methodology*

The overall research work has done in three major phases such as: data collection, data processing, and analyzing the output. During data collection phase, data and information for the study was collected through careful view of recent reports, other relevant secondary sources of data such as published and unpublished documents were collected from pertinent institutions such as the city bus enterprises, Addis Ababa transport authority, Addis Ababa road authority, Addis Ababa traffic police, taxi associations, central statistics agency (CSA) and from different related research papers. Maps, local development plans of various areas, statistical data, administrative documents and etc were collected and analyzed. Road safety and traffic accident matters' stakeholders meetings, discussions and arguments done on state owned TV and which was broad casted online (13 May 2011), and similar video recordings of Addis Ababa are reviewed. It has contributed a great role for this study to understand different stakeholder's current views and interests towards Addis Ababa transport system. Moreover, discussions were also conducted with experts from Addis Ababa transport authority and municipality of Addis Ababa. This was done in order to validate some grey areas which could not be effectively filled through the evaluation of secondary materials.

As the structure of this study will be briefed (see section 1.7) in detail, situational analysis of the case study city was assessed based on systematically collected quantitative and qualitative data. Computer software (SPSS) is used to manage and organize quantitative data out puts. Finally, based on the analysis main findings of the study had identified. And then conclusion of the study and plausible solutions for the problems were recommended.

## *1.5. Significance and scope of the study*

The final study result of this paper will have significant value:

- The outcome can be used as a springboard for further studies in the urban transport area in city of Addis Ababa.
- Identified factors of sustainable transport systems' accessibility/mobility and final recommendations could be used as directive information for different purposes by stakeholders of Addis Ababa transportation.

The /scope of this study/ is limited on sustainable transport systems' accessibility/mobility issues of transportations in Addis Ababa case. Its principal focuses will be on issues related with public transportation (e.g. passengers using city bus and shared taxi, pedestrians' and transport infrastructure matters etc).

## 1.6. *Limitations of the study*

- Secondary data often do exist but are fragmented between numerous sources which make their processing and use difficult. Statistical data management often lacking or, even if existing, it is underperforming and sometimes contradicting each other from one source to the other.
- Selected /or only some/ transport sustainability performance indicators (see table 2.2) was focused and used to evaluate Addis Ababa's transportation role in enhancing different (economic, social, environmental) goals. And that (omitting some) might have to some extent result on unforeseen impact or negative impact on the out of the study.
- Un availability of up to date sources of relevant data in some aspects and lack of research done on similar context in Addis Ababa may have some impact on the out of this research but won't significantly affect validity of this research result.

## *1.7. Structure of the thesis*

The structure of this study is organized in a framework of Fig 1.1; on which introduction comes first as chapter one and recommendation will be forwarded at the end. In introduction section, general information of current global urban transportation matters were described shortly and then specific study area concerns and problems are highlighted taking a bird's eye view on Addis Ababa. Moreover, research objectives, research questions, methodology, significance and scope of the study and probable limitations of the study was discussed.

The study topic 'sustainable transport system' cover a wide spread aspects of economic, social, and environmental matters, and furthermore it consists various views of different scholars and professionals. Therefore, to identify and know the current status of arguments in this regard, and to have information

which might support this study's objective, reviewed from different sources of literatures in chapter two. Moreover, summarized performance indicators and sustainability goals for transport sustainability were drawn out among various critics (set of indicators) by different bodies, which could match better with the study's scope and objective. Transport in relation to mobility and accessibility matters of urban dwellers, sustainability in general and particularly sustainable transport system, type of various transport planning approaches are also reviewed.

The study area (Ethiopian and Addis Ababa) profile will be displayed briefly in chapter 3. It discusses about transport related concerns of Addis Ababa and Ethiopia at large. The population, city development plan, institutional set up, public transport matters will be briefed.

In chapter four sustainable transport systems' accessibility/mobility issues will be analyzed based on performance indicators and intended sustainability goals. And then research findings are discussed in short and overall conclusion of study are also summarized in chapter six. Finally, plausible solutions are forwarded as a recommendation for identified problems (based on main findings).

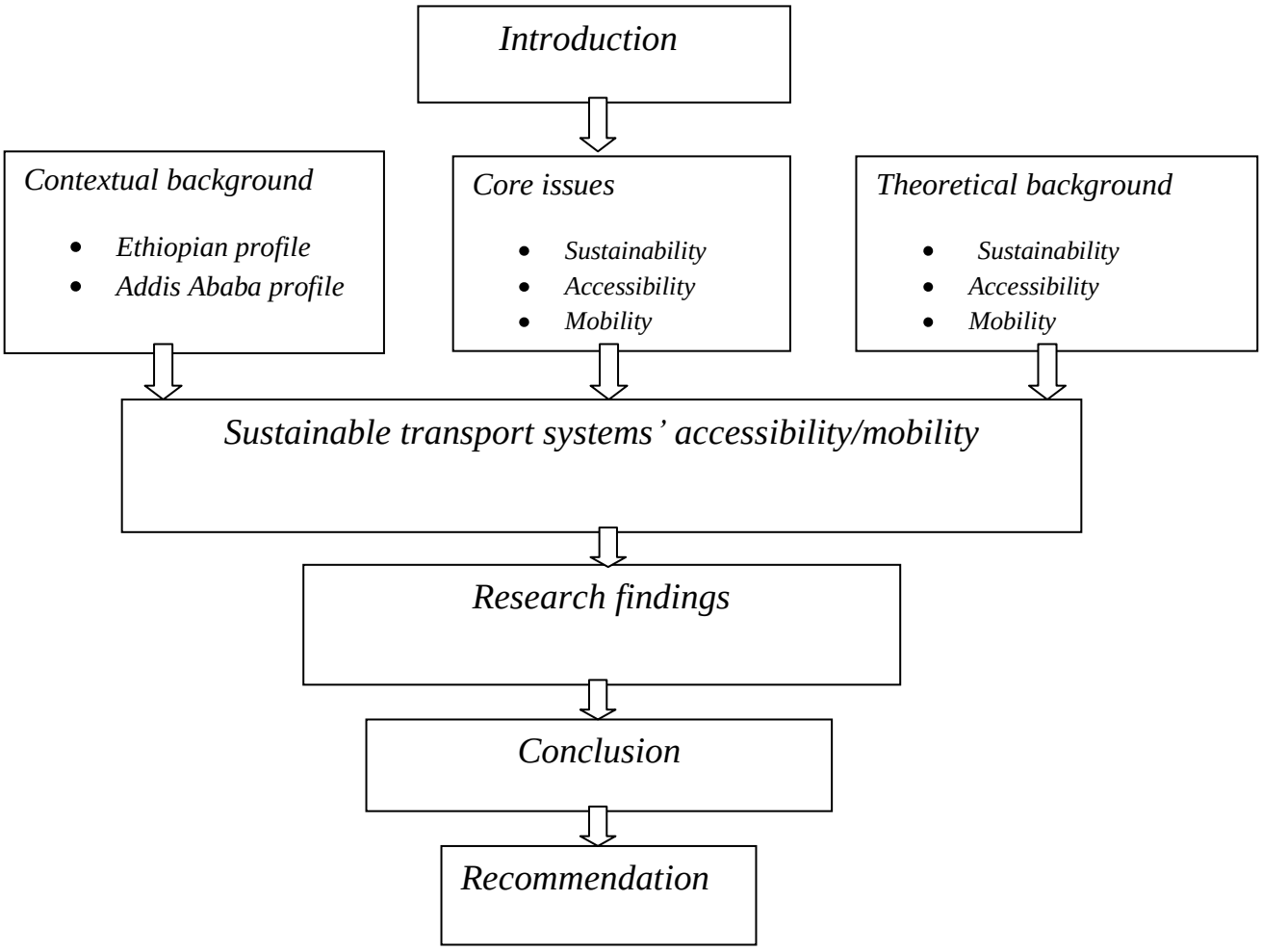



*Figure1.1 Structure of the thesis*

# *2.0. LITERATURE REVIEW*

This chapter gives an overview of the state-of-the-art of literature related to sustainable transport systems focusing on accessibility and mobility issues. Various definitions of sustainability, sustainable development and specifically transport sustainability will be described. Moreover, transport accessibility and mobility characteristics in cities of developing countries in general, and in more specific public transport concerns of cities of some Sub Saharan Africa were briefly reviewed. The final section explains approaches of planning for sustainable transportation and different methods used to measure sustainability in transport matter are presented.

## *2.1. Overview of urban population growth and transport*

The sustained increase of the urban population combined with the pronounced deceleration of rural population growth will result in continued urbanization, that is, an increasing proportion of the population living in urban areas (UN world urbanization prospects, 2007). Globally the level of urbanization is expected to rise from 50 per cent in 2008 to 70 percent in 2050. And again the United Nations Department of Economic and Social Affairs reports show that by 2030, 60 percent of the world's population will live in large urban centers. More developed regions are expected to see their level of urbanization rise from 74 percent to 86 percent over the same period. In the less developed regions, the proportion urban will likely increase from 44 per cent in 2007 to 67 per cent in 2050. The following Fig. 2.1 urban population growth characteristics graph which shows us dramatic urban population growth trend in less developed countries

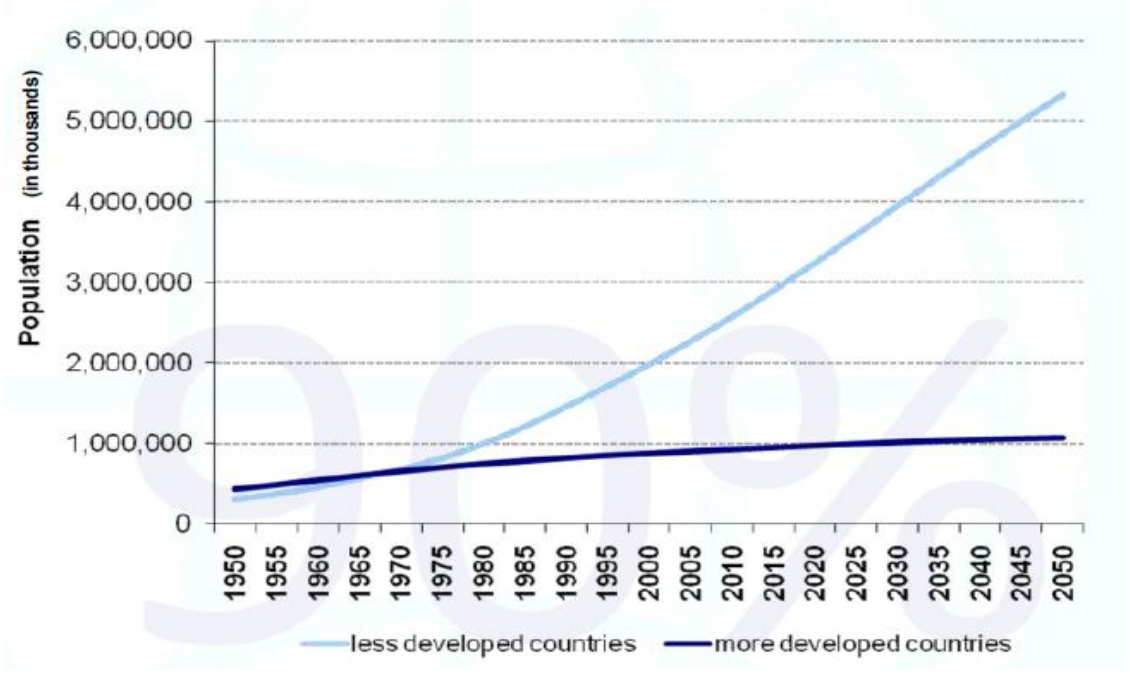



*Figure2.1 Global Urban population growth trend (Source: UN World Population Prospects, 2006 and World Urbanization Prospects, 2007 Revision)*

According to UN world population prospects (2006) and world urbanization prospects (2007) revision report, 90% of urban growth is taking place in the developing world. Moreover, urban populations in Africa and Asia will be double in the next 20 years. It is estimated that by 2020 some 55% of the African population will be living in urban areas (Trans-Africa Consortium 2010). The total population size of developing countries is increasing in dramatic rate; especially in Africa population growth versus less economic development of most countries continues as usual without any significant strategies to cope up with upcoming challenges. Over the coming decades, the level of urbanization is expected to increase in all major areas of the developing world, with Africa and Asia urbanizing more rapidly than the rest.

There are multiple challenges that accompany rapid urbanization. They vary from proliferation of slums to traffic congestion and the intensity of carbon emissions. On the other hand along with current fast rate of urbanization; existence of effective transportation networks is fundamental to the functioning of cities and towns across the globe and a precondition for economic prosperity and the well-being of their residents (UN-HABITAT REPORT, 2010).

- *Economic and social benefits of mobility are frequently accompanied by negative side effects such as congestion, social exclusion, accidents, air pollution and energy consumption, imposing huge costs on local and global economies and impacting negatively citizens' quality of life and the environment.*

## *2.2. Urban transport in social, economic, and environmental context*

Over the recent past there has been a dramatic increase in car ownership and motorization is not only a reflection and outcome of wealth accumulation, but also a catalyst to economic growth through both automobile consumption and production. On the other hand; one of the current serious debates in transportation is motorization; which represents a trend of un-sustainable development as it involves an inefficient use of resources and produces environmental pollution.

In addition to massive passengers flow within urban areas, different types of goods' transport take place, from transport of bulk goods and containers to ports and from ports or industrial areas to consumer goods to retail or people's homes (Visser 2006). And therefore; noise and air pollution (NOx, SPM, SOx) are typically freight vehicle related environmental problems in most countries' urban areas. According to Visser, various countries have different experiences and different approaches regarding urban freight transport policies. For instance, experiences in the OECD-countries (organization for economic cooperation and development) show a broad spectrum of measures that categorized as licensing, regulations and freight routes, freight centers and consolidated delivery, low-emission vehicles and alternative fuels.

Furthermore, OECD formulated policy objective for urban goods transport (Visser, 2006) under the framework of sustainable development (considering goals of environmental, economic and social issues). Different scholars tried to develop and expand more ideas of sustainable transportation. Let us see here goals developed by (Yoram Shiftan et al, 2003) based on the three pillars such as:

Environmental goals: Reductions in air pollution and noise from road vehicles, preservation of open land, protection of wild life and natural habitats, Economic goals such as: Energy savings, minimizing the costs of transportation infrastructure, travel time saving and social goals: Improvement of accessibility to employment, cultural activities and open land areas, maximization of the availability of public transport to the population, increasing road safety by decreasing the number of road accidents and their severity.

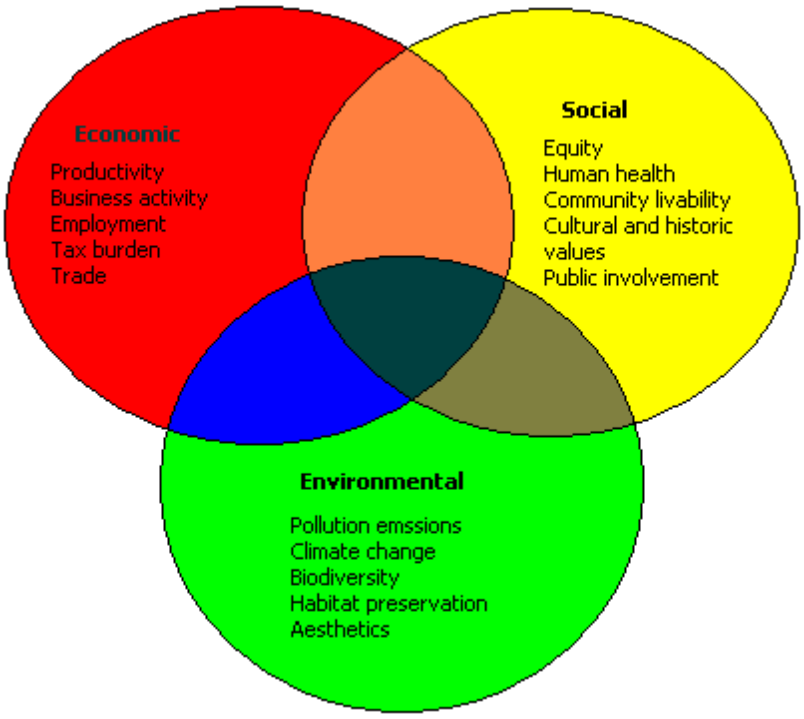



*Figure 2.2 Sustainable Transport Goals (Source: Todd Litman 2010)*

Sustainability in transportation is often depicted as a three-legged stool or triangle, emphasizing those environmental, economic, and social impacts is to be considered simultaneously ("win-win solutions,"),see fig 2.2. Detailed elaboration about "sustainability' and "sustainable transport" will come in later section 2.4 of this chapter.

Transport is a central aspect of the sustainable urban development debate. Motorized urban transport has major impacts on the local (and/or the global) environment, as well as on the quality of life in, and the economic performance of cities (Betolini and Le Clercq, 2003). Urban transport activities are also characterized by various external costs such as: high consumption of energy, green house gas emissions, air pollution, traffic noise, and these could be some of the indicators for environmental problems.

- *Different transport policies and approaches were designed by various bodies to bring sustainable social, environmental and economic outcomes; however fast urbanization and its complicated effects are going on another direction far more than intended plans. The transportation situation especially in Sub-Saharan Africa is in its worst state, and neither sustainable nor on the way to sustainability. The following sub-section will highlight shortly characteristics of un sustainable road transport in Africa.*

## 2.3. *General characteristics of urban road transport in Africa*

Africa has about 2.09 million km of roads of which 21.17% is paved. The quality of roads and their density are still low but the continent's road network yet accounts for about 90 % of inter-urban traffic (African ministers' of transport report, 2008), the distribution of road lengths by sub-region i.e. North Africa 347,451 km. - West Africa 434,910 km. - Central Africa 186,471 km. - East Africa 476,558 km - Southern Africa 574,485 km (this figure excludes South Africa which has relatively better road coverage). The density of the road network is 7.59 km per 100 sq. km, whereas the average road-to-population ratio for the whole continent is 26 km per 10,000 inhabitants, there is a large sub regional variation. Central Africa and Southern Africa have the highest road distribution, with 49.5 km and 56.3 Km, respectively,

for every 10,000 population. These ratios show a great inadequacy and are still too low to provide an acceptable degree of access by disadvantaged populations to the benefits of road transport.
On the other hand, United Nations Economic and Social Council, Africa review report on transport (2009) road transport is the most dominant mode of motorized transport in Africa, accounting for 80 per cent of the goods traffic and 90 per cent of the passenger traffic on the continent. This is especially acute as much of the existing road infrastructure in African cities is far from being appropriate for the actual transport demand (Trans Africa, 2010).

Most of African roads are characterized by variations in standards pertaining to width of both the carriageway and their shoulders as well as on axle load limits. Moreover, in most cases, they do not take into account the needs of the different types of road users; including pedestrians and cyclists. The need to harmonize road infrastructure and vehicle standards was reiterated during the African union (AU) conference of Ministers responsible for road transport in Durban in October 2007.

According to New partnerships for Africa's development (NEPAD) studies of 2006, there are about 20 million road vehicles, both public and private, in Africa of which 11% are estimated to be in Eastern Africa, 21% in Western Africa, 58% in Southern Africa, 2% in Central Africa and 9 % in Northern Africa. Although Africa with its relatively less number of vehicles, less coverage and density, road traffic accidents kill 1.2 million people in the world and of this number over 225,000 or 19 per cent were accounted for deaths in African roads. Moreover, Africa has the highest number of road traffic accidents per capita (UNESC, Africa review report on transport, 2009).

Obsolescence and old age of the continent's road transport fleet is one of the most serious problems of transport which endanger safety, service and competitiveness. The average age of commercial road vehicles (buses and trucks) is 20 years or over, against the 8 to 12 years for developing countries and less than 10 years for industrialized countries. Deterioration rate of road fleet is faster in Africa than other regions of the world due to difficult terrain, poor quality of road infrastructure and the old age of vehicles. Up to 25% of the fleet is off-road (VOR) for maintenance at any time which reflects a very poor utilization rate of about 65,000 km/year against 100,000 in Asia and 250,000 in Europe. These statistical evidences obviously could indicate that existence of unsustainable transportation trend in Africa, and which in turn have significant impact on continent's economic development and competition with rest of the world.

- *Africa still need not only significant investment in transportation sector but also revision on their transport policies too, for instance from conventional transport planning towards modern transportation planning notions (such as accessibility based transpiration planning focus which will be explained in next sections). Concepts of sustainability, mobility, and accessibility and moreover interaction among them will be briefed in relation to transportation issues in a way that to support and clarify more the directions of this research focus.*

## *2.4. Sustainability and Sustainable Transportation System*

It is very common to see the word "sustainability" in a number of books, journals and papers Arguments on concepts of 'sustainability' in different topics, growing interest in concepts of sustainability and fields of study in the last decade or so. The term 'sustainable development' cited in (Litman, 2011) emerged in the 1980s as researchers began studying the systematic relationships between human societies and their effect on nature. The Brutland report, published in 1987 by WCED (World Commission on Environment and Development), was the first major intergovernmental report codifying the term 'sustainable development' as a strategy of sustainable development has now broadened and often is referred to with one word, 'sustainability.'

Most literatures agree that Brundtland report (WCED, 1987) popularized the term 'sustainable development', but this report did not coin it. Here due to its comprehensiveness and complexity of criteria to bear sustainable development, that could fit ecological, economic and social values as the same time Brutland report remain for further debates. The more effort that society has put into developing more sustainably, the more clearly it has started to comprehend the full complexity of that task (Jordan, 2007). The notion of the Brutland report gives emphasis on achievement of sustainable development, which requires the integration of its economic, environmental and social components at each level. This is facilitated by continuous dialogue and action in global partnership, focusing on key sustainable development issues. And then gradually sustainability and sustainable development have become buzzwords for any desirable strategic policies.
Behind the definition and how to implement the concept of sustainability a serious debate raise among key stake holders, like a great political controversy or groupings started to be seen between industrialized north and the industrializing south of the world. For instance; a new era of economic growth in the south to alleviate chronic poverty, and much more resource efficient growth in the North to address mounting social and environmental concerns (Jordan, 2007). Environmental concerns such as pollution either due to polluting industries or automobiles exhaust gases and the measure to be taken to minimize the effect of it conceived differently by developed world and developing regions of the world. Developing countries give more priority towards poverty alleviation and economic growth rather than environmental concern, for instance transportation of goods and people from one corner to other end by any means get more attention than the quality of environment issues for developing countries. Solving future challenges in a sustainable and equitable way requires a complete break from existing systems of decision making (Hall, 2011).The way how we define it may have great role to achieve goal of sustainable development and thus different bodies define it in different and/or duplicated ways.

Sustainability is sometimes defined narrowly as simply environmental sustainability, concerned only with environmental protection goals such as pollution reduction and habitat preservation, but it needs more broadly to include other goals (Todd Litman, 2011). To understand sustainability in a better way let us first see some the following examples of commonly known definitions:

According to world commission on economic development (WCED 1987), sustainable development is "development that meets the needs of the present without compromising the ability of future generation to meet their own needs". This definition immediately comes up with much other scholarly debate. Lele (1991) argue that, according to Brutland's definition sustainability being about everything and therefore potentially nothing that means it was defined in a way that vague manner and something which is not easy to realize or implement in various complex real world situations.

The Oregon Sustainability Act of 2001 (ORS 184.421) defines sustainability as using, development and protecting resources in a manner that enables people to meet current needs while providing for future generations to meet their needs, from the joint perspective of environment, economic and community objectives.

And thus constant process of redefinition and interpretation has taken place since 1987 on sustainable development without fixing a precise definition rather exploring the interplay between different sub-principles of sustainable development. Among those definitions which focuses more on improving intergenerational equity is "Sustainability is equity and harmony extended into the future, a careful journey without an endpoint, a continuous striving for the harmonious co-evolution of environmental, economic and socio-cultural goals." (Mega and Pedersen 1998)

Moreover, Wilson defined sustainability in terms of efficient resource utilization "The common aim [of sustainable development] must be to expand resources and improve the quality of life for as many people

as heedless population growth forces upon the earth, and do it with minimal prosthetic dependence (Wilson 1998). Different scholars attempted to categorize interpretation of sustainability however still lack common consensus and there is ideological differences for instance typologies of sustainability typically lack epistemological consistency, or logical arguments to order the categorization process (Davidson 2011)

There are a growing interpretation of transport sustainability and how to evaluate sustainable transport system. Let us see some definitions and interpretations addressed related to transport sustainability:

European Conference of Ministers of Transport definition (ECMT 2004), is well known "A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable."

Sustainability is not about threat analysis rather sustainability is about systems analysis. Specifically, it is about how environmental, economic, and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation." (TRB 1997) , on the other hand center for sustainability defined "sustainability" considering only long lasting of something without considering benefits, advantage and/or disadvantage rather sustainability is the capacity for continuance into the long term future. Anything that can go on being done on an indefinite basis is sustainable. Anything that cannot go on being done indefinitely is unsustainable." (Center for Sustainability 2004)

"A sustainable community is one that is economically, environmentally, and socially healthy and resilient. It meets challenges through integrated solutions rather than through fragmented approaches that meet one of those goals at the expense of the others. And it takes a long-term perspective— one that's focused on the present and future, well beyond the next budget or election cycle." - Institute for Sustainable Communities (ISC 1997)

Although sustainable transportation can be seen as an expression of sustainable development in the transportation sector, many of literatures define and using "sustainability " in transportation in many ways ,and therefore what does it really mean in general: lower emissions? of local or global pollutants? Lower congestion? Higher accessibility? Fewer accidents? Decreased spending on transport costs? Does it mean all of these? Some of these? A combination of these, and if so, in what doses? How can we know we are being "sustainable" and then, what can we do about it ? and thus the following sub-sections will give detail insights for these questions and dilemmas.

The /Environmental Directorate of the OECD/ defines Environmentally Sustainable Transportation (EST) as "transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes." (OECD 1998)

Transport research board on 'sustainable transportation strategies for developing world explicitly making the link between transportation, basic human needs, and environmental effects. Since then, we have seen an ever increasing number of efforts searching to define, design and measure sustainable transport, (e.g., UN DSD 1992, OESD 1996, world bank 1996, WBCSD 2001, Kennedy et al. 2005, Goldman and Gorham 2006; etc) are cited in (Zegras 2006).

Identifying policies that will result in a sustainable transportation system is a major challenge for policy makers since it involves a high level of uncertainty regarding the future effect of a given policy package on the transportation system and the urban environment (Yoram Shiftan et al, 2003)

The /World Bank/ has gone on to define what it refers to as /the three pillars of sustainable transport/:

***Economic and financial sustainability*** "To be economically and financially sustainable, transport must be cost-effective and continuously responsive to changing demands."

***Environmental sustainability*** "Transport has significant effects on the environment that should be addressed explicitly in the design of programs (and systems in general). Making better use of readily available and cost-effective technology is necessary, but not in itself sufficient. More strategic action is also required in the form of better-directed planning of land use and stricter management of demand, including the use of pollution and congestion charges to correct the relative prices of private and public transport."

***Social sustainability,*** commonly known as equity "Transport strategies can be designed to provide the poor with better physical access to employment, education, and health services." In addition, customer satisfaction is a key ingredient in creating a socially sustainable transport system.

One state department of transportation (DOT) in the United States defines sustainable transportation concisely as "the provision of safe, effective, and efficient access and mobility into the future while considering the economic, social, and environmental needs of society'(Litman 2011)

Today the issue of car dependent urban transport calls for urgent sustainable means of transportations, per capita distance travelled by car is the most widely accepted (un)sustainability indicator of urban transport (Wegener and Furst, 1999) moreover, with the notion of less or no car use increase, Newman and Kenworthy (1999) define the unsustainable urban transport patterns as 'automobile dependence'. Benchmark for a sustainable transport system was suggested by (EC's SUMMA, 2003;European Environmental agency, 2003; Kennedy et al. 2005) as accessibility, health and safety, cost effectiveness, impact on competitiveness and generation of wealth, consumption of natural capital, and production of pollutants (local and global scale). All of these needs to be measured to understand the synergies between different intervention measures and the above indicators can be used to assess the progress towards transport sustainability at national and city-regional levels but will be dependent on improvements to the quality and the robustness of data collected (Hull, 2011).

An attempt to categorize different interpretations of sustainable transport system and the complexity of the debate on it also yet not get single holistic definition that satisfies all. And thus the question, what is sustainable transport /system/? It has no exactly this or that kind of answers, since there are different sources of interpretations that are under framed in the objectives of interpreter. Moreover, as far as if someone is only concerned on a single definition or interpretation, he/she might have a probability to be under boundary of narrow view. Thus, among others due to its comprehensiveness and wide view definition of CST (see sub-section 2.4.) becoming more familiar recently in transport sector. Therefore, throughout this study (paper) sustainable transport system mean it is "CST's" definition

- *According to /Canadian Centre for Sustainable Transportation/ CST 2005): definition, sustainable transportation system is one that:*
  - *Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between successive generations.*
  - *Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.*

- *Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise*

It is one of the best recently evolved definition for sustainable transportation which accounts on its definition the welfare of economy, environment, and society and this 'triple bottom line' approach and it has been adopted by American Association of State Highway and Transportation Officials (AASHTO) and many other organizations. Therefore, CST definition is best comprehensive and will be used as a framework for this research work too. Even though, there are many possible definitions of sustainability, sustainable development and sustainable transport, many experts increasingly agree that it should refer to balancing economic, social and environmental goals, and thus CST definition for transportation sustainability also considers these three basic pillars.

☞ *In general, attempts to categorize the different interpretation of sustainability and the complexity of the debate on it yet not get single holistic solution. Transport sustainability planning process must be comprehensive and integrated, considering all significant objectives, impacts and options. It should begin by defining goals (what we ultimately want to achieve), defining planning objectives (way to achieve goals), targets (specific, reasonable, measurable objective that we want to achieve), and outcomes (ultimate changes in activities and impacts, such as travel activity, consumer costs, accidents, pollution emissions, etc). Sustainability concepts are used accordingly based on the field of study, organization goals, and its most definition above basically refers to 'the capacity to endure.' Beyond these view there is little agreement on what this term actually means but it is widely recognized in academia, government and policy circles that humanity is living unsustainably. For instance in sustainable urban development notions, such as enhancing sustainable mobility and accessibility are among the basic points. However, it lacks to satisfy various habitants need, which should be considered during transport planning, and thus the following sections will review this concept.*

### *2.4.1. Mobility*

The following sections describe the concepts of accessibility, mobility in general, and more specifically sustainable mobility characteristics, the difference between mobility based planning and accessibility based planning will be reviewed.

Mobility could be defined as 'the ability of an individual, or type of person, to move about' Jones as cited in (Hull, 2011). Simply measured mobility has two components: One is determined by the availability and density of the transport system to that individual, household or firm in their current locations. The other characteristics of the individual, for example do they have a car available or are they able to use public transportations? However, the World Business Council for Sustainable Development defines sustainable mobility as 'the ability to meet society's need to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values, today or in the future' (WRI, 2004). In other way, Sager as cited in Nout (2010) defined mobility as the potential transport rather than revealed transport. Potential transport is valued highly, it increases freedom of choices. Revealed transport is usually seen as a necessary evil, and the unlimited growth (hyper mobility) will induces a lot of environmental problems. Moreover it has a potential to impose stress on the transport system and make people depend on their car, disconnecting them from various social interaction. Hyper mobility sometimes seen as "too much of good thing" (Adams, 2005)

An increasing level of car use leads to greater mobility, and it has been implicitly assumed for years that there is a close link between mobility and wealth. Further, motorization is not only a reflection and outcome of wealth accumulation, but also a catalyst to economic growth through both automobile consumption and production (Sun Sheng Han, 2010).

In contrast to Sun Sheng view Banister argue that, to achieve suitable mobility, the arguments must be sufficiently powerful to overcome the dependence on the car and the possibility that the costs of delay and congestion have already been internalized by drivers (Banister, 2008). Here the intention is not to prohibit the use of car, which is of course not possible and individual choice and freedom to use it; but the focus of argument of Banister is on how to make people not need to have a car as a best alternative for mobility. Recently this concept is getting broader acceptance even in political agenda's of the western world, Hull, (2011) shifting the modal balance of transport away from transport reliant on non-renewable sources of fuel is at the core of the organization for economic co-operation and development (OECD) and the EU council of ministers' strategy for integrating environment and sustainable development into the transport policy. The successful management of demand for private transport use would require action at the national and regional government levels. But for developing countries on the era of globalization to enhance economic development rapidly, and to promote private investment, the role of increasing private car ownership is crucial and on the other hand it is contradicting with sustainable transportation goal.

Moreover, there is a significant dilemma on trying to make urban development less dependent on car and inability of most alternatives to match the quality of accessibility provided by private motorized transport. And thus to achieve sustainable urban mobility with economically no less competitive, socially and politically no less acceptable vision for the integration of sustainable transport and land-use patterns in urban development strategies are required (Bertolini and Le Lercq, 2003).

- ☞ Potential mobility is sub-set of sustainable mobility and it is closely linked to accessibility. Focusing only on mobility facilitating may lead to a decrease in social cohesion.

### *2.4.2. Accessibility*

Accessibility can simply be defined as an ease with which people can access services at different locations (Hull, 2011). In similar way to Hull's definition (Betolini and clercq 2003) incorporating travel time; defined it as the amount and the diversity of 'spatial opportunities' that can be reached within a certain amount of time. Accessibility (or just access) refers to people's ability to reach desired goods, services, activities and destinations (together called opportunities), see Litman 2003. For example, fast food restaurant provides access to foods such as burgers, a store provides access to goods, a library provides access to information, and train, taxi, city buses etc provides an access to public transportation.

In conventional transportation planning a generic mobility issue is one of the basic concerns. However, current literatures reveals that facilitating people's opportunities to participate in spatially disjointed activities in an easy ways or mechanisms is becoming major agenda on sustainable transport accessibility notions.

There are several factors which have impact on physical accessibility such as travel time, cost of travel, location of facility and services, transport mode and timing of service delivery. As a perceived attribute of a physical location it can be quantitatively measured using topological, cumulative opportunity, population potential or space-time measurements of accessibility, separately or in combination (Handy and Niemeier 1997; Hoalden et al. 2000; Weber 2006).This measures essentially compute the interconnectivity of locations and services, which people are assumed to need, using the available transport system.

Accessibility for public transportation or destination for someone who has his/her own private car is less problem than urban poor, and thus for those group who do not depend on public transportation accessibility of roads will be more important. Access to roads with good parking space, safety, better road capacity and a dense road networks will be more important for private car owners to reach any destination where desire to go. For those people who have no private car accesses; public transport accesses will be much more important and if this group of people could not get sustainable public transport access both economic (employments, shops, education etc) and social activities will be seriously affected.

Authors like Levine & Garb (2002) identified the measures that must be taken to improve mobility and accessibility and they also mentioned difference between among these measures as:

> "A mobility improvement is a reaction in the ***generalized (i.e. time-plus-money) cost of travel per kilometer***; and an accessibility improvement is a reduction in the ***generalized cost per destination***" (Levine &Garb, 2002)

- *Thus, increasing transport capacity to relieve congestion might affect negatively business movement to various corners of the city, further from the central business districts (CBD) and thus customers are forced to pay generalized costs for those specific locations. Facilitating mobility without critical thinking of its side-effects will result in unsustainable transportation. And thus transport planners don't just look at the best or cheaper way to facilitate certain transport flows, but they include environmental quality and involve the people in the planning considerations (Banister, 2008)*

### *2.4.3. Planning for sustainable transportation*

One of the global challenges of 21st century is the issue of transport sustainability, and how to control ever increasing use of motorized modes of transport. Motorization represents a trend of un-sustainable development as it involves an inefficient use of resources and produces environmental pollution. This is particularly true in private car-based transport systems where sustainability is threatened by exhaustion of the finite fuel reserves, emissions and air quality, congestion, fatalities and injuries, and land use sprawl (Black, 2000) as cited in (Sheng,2010). And thus, the sustainability-with-accessibility goals can be achieved if households and firms can link the same or a greater number and diversity of places of activity other than by car (Bertolini and Clercq 2002), without travel, by walking or cycling, by transit, or by more efficient use of (cleaner) cars.

Transportation planning usually uses a cost-benefit approach or a multi-criteria analysis that has initially been developed to analyze the effects of new transportation infrastructure or public transport services have been expanded to evaluate the environmental impact of transportation projects, as well as to analyze the sustainability of transportation alternatives (Yoram Shiftan et al, 2003). Planning for a sustainable transportation system is a complicated task that involves a high degree of uncertainty due to large number of alternative potential policy packages (e.g. pedestrian and bike use encouraging policy), the way of implementation those policies and the travelers_ response to each of these policy packages. Moreover, planner's practice and the way how policy makers define and interpret the concept of sustainable development has also great impact on transportation planning.

## *2.4.4. Mobility based transportation planning*

The main objective of mobility-based transport planning is encouraging fast means of movement of goods and/or passengers. But this is a rather narrow view of the role that it could play, as there is a newer more modern literature about distance, speed and time (Banister 2010). Moreover, mobility based planning assumes that mobility is an end in itself and ignores strategies that improve accessibility without increasing mobility such as more accessible land use development. On the other hand improved road-based freight movement appears to ignore shifts to rail and water transport as possible freight improvement strategies although they are more resource efficient (Litman 2011).
Conventional transport planning often evaluates transport system performance based primarily on mobility (using indicators such as traffic speed and vehicle operating costs), ignoring other accessibility factors and improvement options. According to (Banister 2011), the conventional transport paradigm is heavily embedded in the belief that travel time needs to be minimized and consequently speeds need to be increased. The resulting impacts on travel distances have not been part of that debate, but reducing travel distances is central to sustainable transport.
Moreover, increasing mobility could be seen as making travelers destinations more easily accessible, that means some locations with good public transport connection are preferable for activities and services that generate a lot of traffic. A reduction in generalized cost per destination is necessary to improve accessibility for a certain services or business (Levine & Garb, 2002)

The notion that all travel is a derived demand may become weaker as incomes rise and as leisure time becomes more valuable (Mokhtarian and Salomon, 2001) as cited in Banister (2008), and therefore travel is not always a cost. Moreover due to the introduction of various information technologies (ICT) and strong complementarities between (old) transportation and ICT (Stead and Banister 2004) 21$^{st}$ century transportation trend is interdependent and complicated in many aspects. Travel can be replaced by more "at home activities", whilst in other cases more spontaneous travel is generated, and in a third group there is a modification of existing activities, as shopping for example becomes a multitasking activities through a combination of the internet (e.g. viewing, deciding and baying) and travel (e.g. collection or delivery), Banister (2008)

- *In mobility based transport planning, there is a contradiction between the desire to speed up and on the other hand desire to slow traffic down (much effort is now going into slowing traffic down for environmental and safety reasons). For instance, basic notion of this approach is to speed up traffic flow either by widening the shoulders of the roads or constructing additional road networks to those traffic congested routes, but on the other hand worry for its traffic accidents and put various enforcement measures like speed limit. Therefore such fallacies could be minimized by first critically knowing the reason why those travelers are using the specific route or going to that specific congestion prone destination (area). Secondly, facilitating services or land use mix concept need due attention. Thus, to enhance sustainable mobility approach reducing the need to travel (fewer trips), encouraging modal shifts, reducing trip lengths and encouraging greater efficiency in the transportation system should be basic policy measures.*

## *2.4.5. Accessibility based transportation planning*

This type of transportation planning is becoming widely acceptable in current transport sustainability notions that focus on spatial opportunities rather than mobility. Access is the ultimate goal of most transportation, (Litman 2011) excepting the small portion of travel in which movement is an end in itself, (e.g., cruising/travel on ships for pleasure, historic train rides, jogging, etc). According to Banister (2008) the reason for current car dependence increase in urban area is due to local public transport, cycle and walking have become less attractive, and this in turn has resulted in the greater use of the car. The quality of the transport service, for example how train compartments, car interiors, bus stops and stations can all be better designed, so that travelers can better choice public modes of transportation.

Cities would be designed at the personal scale to allow both high quality accessibility and a high quality environment (Banister 2008), the intention here is to let people not need to have a car at a suitable scale. The challenge of looking other options rather than mobility require critical thinking about cities futures in terms of the reality (what is already there) and the desirability (what we would like to see) and the role that transport can (and should) play in achieving these objectives.

For instance, with mobility-based planning, the only practical solution that could be assumed as a solution to traffic congestion is to expand roadway capacity either by constructing other routes or expanding the exiting congested route; however, accessibility-based planning allows other solutions to be considered, including improvements to alternative modes, more accessible land use patterns, and improvement to mobility substitutes like telecommunication service. There are factors which have significant role in transport accessibility planning such as: road and path connectivity, land use patterns (distribution or the location of activities), mobility substitutes (ICT and delivery services), mobility (physical movement), affordability of an option, information availability, and social acceptability are some of the factor that may affect accessibility and all need due attention during transportation planning. Moreover, supporting resource-efficient solutions towards sustainable transportation problems and careful selection of transport sustainability indicators reflect accessibility-based planning.

Over the recent past there has been a dramatic increase in distance and speed travelled, that has its own negative impact on fixed travel time budget or it indicates less travel time savings. One very powerful argument that has been central to transport thinking is the notion of travel time budgets (in the UK it is about 62 min per person per day – DfT (2009, Table 3.6)) and these levels have remained constant over time. This means that with faster travel one can get to more destinations (choices) within the available budget.

Speed and time have dominated the debate on transport to the exclusion of distance, which has only been seen as the consequence of decisions made in the transport sector (Banister 2011). In urban areas of developing countries like Ethiopia; land use policies should be related with travel distance and support compact, mixed, connected, multi-modal land use development in order to improve land use (functions) accessibility and which in turn provoke sustainable transport development.

Adam (2004), "when time is money, then faster is better" concept of transportation planning is argued by Banister and other; newer more modern literature about strengthen the focus on the distance element, and to explore the means by which travel distances can be reduced. This may result in reductions in travel time and in travel speed, and this would be beneficial in terms of travel time saving and reductions in the use of energy (and carbon). There may also be social benefits as it would be easier to provide high quality public transport and the full range of local services. This in turn would provide a major contribution to the achievement of a sustainable transport system. During policy formulation to minimize travel it is very important to note demand driven travel, reasonable travel time and time minimization should focus on extra travel time ( not reasonable time plus time spent travelling to leisure) to get something from somewhere else.

- *Accessibility planning could contribute a lot for the reduction of an overall transport cost. Not only monetary costs, rather environmental and social costs could be reduced significantly and thus, accessibility is sustainable mobility.*

## *2.4.6. Mobility and social issues*

Consequently, a major challenge for cities all over the world in the 21st century is to meet the mobility needs of their residents in a socially inclusive, economically efficient and environmentally sustainable manner (UNHBITAT, 2010). Sustainable transportation planning takes in to consideration the issue of social cohesion which will be affected due to less livability. Access to people, places, goods and services

is important to the social and economic well being of communities. Transportation is a key means, but not the only means, through which access could be achieved (litman, 2011).

*Livability* refers to the subset of sustainability objectives that directly affect community members (litman, 2011). Livability and sustainability generally share the same objectives, but often with somewhat differing perspectives and priorities. For example, both justify efforts to reduce pollution, although sustainability often focuses on climate change emissions while livability focuses on local air and noise pollution.

In urban areas distance travelled has grown dramatically over the recent past, and all activities depend on travel and movement to get people and goods to where they are needed. Present lifestyles depend on travel and there are huge benefits from this increased mobility (Baniester, 2011).

Indeed, mobility for some will be at the expense of immobility and disease for others (Low, 2003, p. 22) This means; that the growth in travel distance needs to be reassessed with a view to reducing it, as shorter distances and slower travel have positive co-benefits for the environment (including safety), energy (and carbon), social inclusion, wellbeing (including health) and the economy. On the other hand some may argue promoting more efficient and alternative fuel vehicles help conserve energy and reduce air pollution, but by increasing total vehicle travel contradict others. Vehicle travel reduction strategies help achieve more objectives and so can be considered more sustainable, (Litman, 2011). Both the empirical and theoretical evidence challenges the continued emphasis over the need to speed up transport to 'save time' and the assertion of constant aggregate travel time budgets (Metz, 2008b).

There are also strong social limitations, as not all people have access to the car, and not all want to or can afford to travel long distances (Knowles, 2006). Although society as a whole may be car dependent, there are still a large number of people (about 30% of the total population) that will never be able to drive a car as a consequence of limitations such as age, disability and cost, and even choice (Banister, 2009). So the more choice argument and the wider range of alternatives can be seen as a means to increase the mobility for many, but decrease in the opportunities for others if alternatives to the car are not available.

Travelling by car offers far more convenience, independence, flexibility, comfort, pleasure, safety and speed than travelling by public transport (Harms, L., et al, 2007); people have a predominantly positive view of travelling by bicycle-in addition to the low costs, people also value 'always arriving on time' and 'being by oneself'. Travelling by bicycle is also seldom associated with annoyance or delays.

Moreover, the summary report of 'Kennisinstituut voor Mobiliteitsbeleid' on 'Beleving en beeldvorming van mobiliteit' in Netherlands reveals that individual characteristics such as age, gender and level of education also influence experience and attitudes towards travel mode choice. For instance, women are less harsh about the quality of public transport and see bicycle travel more frequently as a valid alternative; cars are especially popular among young people, while older persons have a more positive attitude towards public transport. The differences in experience are also the result of spatial aspects. Moreover, the study showed that travelling by car is considered the most attractive mode of transport. Cars and bicycles most preferred, public transport least popular. Result of the Kennisinstituut voor Mobiliteitsbeleid' study highlights us planning for sustainable passenger transport system require considering of individual's (planning for whom) differences in perception and experience towards different mode of transports such as the use of cars, bicycles, or public transport.

Travel is a space–time in which social differences are constructed in various ways, including the operation of regulatory, financial, physical, cultural and other mechanisms through which certain people are excluded from travelling in a certain manner. However, differentiation and 'othering' also take place

through gestures, looks and practices of travelers sharing a transport space and through other logics. Most of the social barriers currently facing transport decision makers are balancing the complexity of conflicting social, environmental and economic objectives (Banister, 2010)

☞ *The conventional transport analysis has been desired to 'save travel time' by increasing speed just without any mechanism to reduce distance travelled which has many drawbacks. In general, conventional transport planning contradict sustainability goals by increasing per capita resource consumption, traffic congestion, road and parking facility, costs, traffic accidents, pollution emissions and land consumption, and reducing travel options for non-drivers, exacerbating inequity. However, exploring the means by which reducing distance travelled will have significant role for sustainable transport. Moreover, transport system sustainability has to be evaluated by some means of indicators of transport sustainability. And based on those indicators it is also possible to identify both potentials and constraints in an attempt of enhancing sustainability.*

## *2.4.7. Indicators of sustainable transport system*

The following sub-section will give an insight for what constitutes transportation sustainability and how to measure it? Indicators are things we measure to evaluate progress toward goals and objectives, for transportation case sustainable transportation goals and objectives (Litman, 2011). They can help us to identify trends, predict problems, assess options, set performance targets, and evaluate a particular jurisdiction or organization. In other words performance indicators are specific factors that are measured to indicate progress toward goals. Beyond general definitions and visual images, one approach taken by communities, policy makers, and advocates to opertionalize and communicate about sustainability is the use of sustainability indicator systems (Slotterback, 2010). In most situations, no single indicator is adequate, so an index (a set of indicators) that reflects various objectives and impacts should be used. Indicators will vary (Zegras 2006) depending on spatial and temporal scale of the analysis and on the ultimate goal, even if common indicators can often apply to several different goal and/or scales of analysis.

Although the importance of setting indicators is crucial, there is still no comprehensive and single standardized sustainability indicator sets. Currently different transportation indicators are being developed. However, some of them are appropriate and commonly used, others are still ambiguous, and a few are illogical or narrow viewed. Moreover sustainable transport guiding principles and indicators are used to establish approaches that are holistic, long term and community oriented (Muhammad & Nicholas, 2009). Some of the indicators that are developed by different organizations (bodies) to measure transport sustainability are listed as follows:

- *Current transportation performance indicators*

Transportation planners use various performance indicators for evaluating transportation conditions, prioritizing improvements, and day-to-day operations (Litman, 2011). Meyers (2005) describes and compares various performance indicators related to roadway conditions (congestion, travel times, crashes), freight transport efficiency, pollution emissions, quality of various modes (including walking, cycling and public transit) and user satisfaction.

- *Mobility for people with special needs and disadvantages*

Sustainable transportation is equitable and evaluating its capability to serve all section of the people within the societies such as wheelchair users, people with sight problems and with very low income

(Richert and Litman 2005). And therefore, evaluation of transportation system features in terms of their ability to accommodate people with disabilities is one of the basic indicators of sustainable transport.

- *World business council sustainable mobility indicators*

Indicators developed for the World Business Council's Sustainable Mobility project which comprises user concerns, societal concerns, and business concerns.

- *TERM indicators*

The /European Union's Transport and Environment Reporting Mechanism (TERM)/ identifies the sustainable transportation indicators to evaluate transport sustainability in the TERM project (EEA 2002).

- *Indicators by category (economic, social, and environmental)*

The three main categories used for measuring sustainability in transportation systems correspond to the main domains of sustainability: environmental, economic, and social, i.e. each with several sub-categories.

*Economic indicators:* The economic domain has been categorized into pricing and taxation, and expenditures and subsidies. Economic development refers to a community's progress toward economic objectives such as increased income, wealth, employment, productivity and social welfare. Welfare (as used by economists) refers to total human wellbeing and happiness (Litman 2011). In accessible communities people can reach most destinations using low-cost modes such as walking, bicycle, wagon and public transit, but increased automobile dependency tends to reduce the performance of these modes ("Automobile Dependency," VTPI 2008). Therefore using economic indicator it is possible to see or evaluate how far the transportation is sustainable for its users.

Moreover, according to Litman (2011) sustainable transportation economic indicators should reflect both the benefits and costs of motor vehicle use, and the possibility that more motorized mobility reflects a reduction in overall accessibility and transport diversity, rather than a net gain in social welfare. Increased mobility that provides little or negative net benefits to society can be considered to reduce sustainability, while policies that increase the net benefits from each unit of mobility can be considered to increase sustainability.

*Social indicators:* Social impacts include equity, human health (e.g. accident injuries, pollution illness, and inadequate physical activity), community livability (local environmental quality as experienced by residents and visitors) and community cohesion (the quality of interactions among community members), impacts on historic and cultural resources (such as historic sites and traditional community activities), and aesthetics. Transportation equity can be evaluated by comparing transport options, service quality, impacts on different groups, particularly on economically, physically and socially disadvantaged people (FHWA and FTA 2002; Caubel 2004; Litman 2005a).

*Environmental Indicators:* Environmental impacts include various types of air pollution (including gases that contribute to climate change), noise, water pollution, depletion of nonrenewable resources, landscape degradation (including pavement or damage to ecologically productive lands, habitat fragmentation, hydrologic disruptions due to pavement), heat island effects (increased ambient temperature resulting

from pavement), and wildlife deaths from collisions. Various methods can be used to measure these impacts and quantify their ecological and human costs (EEA 2001; Litman 2009; FHWA 2004).

According to Litman, currently there are good growing attempts on how to define and select indicators for sustainable transportation. Sustainable transportation indicators used by different bodies sometimes may vary and/or overlap on specific aspects. The number, types (sector-specific), purpose, design of sustainable transportation, and the way how they were selected and organized may vary from one organization to other organization, for instance there are:

- Aviation sustainability indicators
- GPI sustainable transportation objectives and indicators (GPI 2008)
- Lyons regional indicators
- Livability objectives and indicators
- regional sustainable transportation principles and indicators (York Region 2009)
- Texas Department of transportation (Zietsman, et al, 2008) and etc

Some of these indicators are appropriate for specific mission or to achieve only that target, but others may actually promote unsustainable policies if we use them as they are, because they don't consider some basic issues which are very important in general sustainable development notions. For instance some of them ignores social objectives such as improved mobility for non-drivers, increased affordability, and improved public fitness and health from increased walking and cycling, others ignore environmental impacts such as loss of open space (directly, by highway facilities and indirectly, by stimulating sprawl), habitat loss and water quality impacts. There is apparently no consideration of user costs and indirect costs, such as the costs of providing parking facilities and potential savings from reduced vehicle ownership as potential ways to achieve sustainability.

Basically, transportation systems are supported by three sub-systems such as, activity system, network system and traffic system. These sub-systems are interconnected with each other and influencing each other. Changes in activity system will affect traffic system and in the end will influence network system. But transportation systems are not only influenced by these physical sub-systems but also by other systems, namely, institutional system, internal and external environment system and spatial system (Kusbiantoro, 2007) as cited in Handiyana (2009). And therefore, during the task of evaluating transport sustainability we have to take care of considering all the necessary components of each system.

Sustainability in transport for the above three listed transport systems, require a set of performance indicators that reflects appropriate economic, social and environmental goals and impacts. Table 2.1 summarizes sustainability goals, objectives and performance indicators (Litman 2011).

| Sustainability Goals | Objectives | Performance Indicators |
|---|---|---|
| **Economic** | | |
| Economic productivity | Transport system efficiency.<br>Transport system integration.<br>Maximize accessibility.<br>Efficient pricing and incentives. | ❖ Per capita GDP<br>❖ Portion of budgets devoted to transport.<br>Per capita congestion delay<br>❖ Efficient pricing (road, parking, insurance, fuel, etc).<br>❖ Efficient prioritization of facilities |
| Economic development | Economic and business development | • Access to education and employment opportunities.<br>❖ Support for local industries |
| Energy efficiency | Minimize energy costs, particularly Petroleum imports. | • Per capita transport energy consumption<br>• Per capita use of imported fuels. |
| Affordability | All residents can afford access to basic (essential) services and activities. | • Availability and quality of affordable modes (walking, cycling, ridesharing and public transport).<br>❖ Portion of low-income households that spend more than 20% of budgets on transport |
| Efficient transport Operations | Efficient operations and asset management maximizes cost efficiency | ❖ Performance audit results.<br>• Service delivery unit costs compared with peers.<br>• Service quality. |
| **II. Social** | | |
| Equity / fairness | Transport system accommodates all users, including those with disabilities, low incomes, and other constraints. | • Transport system diversity.<br>• Portion of destinations accessible by people with<br>disabilities and low incomes |
| Safety, security and Health | Minimize risk of crashes and assaults, and support physical fitness. | • Per capita traffic casualty (injury and death) rates.<br>• Traveler assault (crime) rates.<br>• Human exposure to harmful pollutants.<br>❖ Portion of travel by walking and cycling |
| Community development | Help create inclusive and attractive communities. Support community cohesion. | • Land use mix.<br>• convenience for Walk and bike<br>• Quality of road and street environments. |

| | | |
|---|---|---|
| ❖ Cultural heritage Preservation | Respect and protect cultural heritage.<br>Support cultural activities. | ❖ Preservation of cultural resources and traditions.<br>❖ Responsiveness to traditional communities |
| **III. Environmental** | | |
| ❖ Climate stability | Reduce global warming emissions<br>Mitigate climate change impacts | ❖ Per capita emissions of global air pollutants ($CO_2$, CFCs, $CH_4$, etc.). |
| Prevent air pollution | Reduce air pollution emissions<br>Reduce exposure to harmful pollutants | • Per capita emissions of local air pollutants (PM, VOCs, NOx, CO, etc.).<br>• Air quality standards and management plans. |
| Prevent noise pollution | Minimize traffic noise exposure | • Traffic noise levels |
| ❖ Protect water quality and minimize hydrological damages. | Minimize water pollution.<br>Minimize impervious surface area | ❖ Per capita fuel consumption.<br>❖ Management of used oil, leaks and storm water.<br>❖ Per capita impervious surface area. |
| ❖ Open space and biodiversity protection | Minimize transport facility land use.<br>Encourage more compact development.<br>Preserve high quality habitat | ❖ Per capita land devoted to transport facilities.<br>❖ Support for smart growth development.<br>❖ Policies to protect high value farmlands and habitat. |
| **IV Good governance and planning** | | |
| ❖ Integrated, comprehensive and inclusive planning | Clearly defined planning process.<br>Integrated and comprehensive analysis.<br>Strong citizen engagement.<br>Less-cost planning and funding (the most overall beneficial solutions are selected and funded) | • Clearly defined goals, objectives and indicators.<br>• Availability of planning information and documents.<br>• Portion of population engaged in planning decisions.<br>• Range of objectives, impacts and options considered.<br>• Transport funds can be spent on alternative modes and demand management if most beneficial overall. |

*Table 2.1 Key Sustainable Transport Goals, Objectives and Indicators (Source: Litman, T. 2011)*

❖ N.B: red star marked indicators & sustainability goals are omitted during analysis (chapter 4)

Therefore, in this study to evaluate transportation sustainability in case study city, Addis Ababa, performance indicators are used as guidance or baseline except those indicators which are marked by red colored star bullets in table 2.1. Litman summarized transport sustainability performance indicators and major sustainability goals, in a way that to avoid narrow view and scope of different indicators developed by various transport stakeholders. In general, limiting performance indicators result on misleading conclusion and fail to reflect true sustainability. However, these general notions should not confuse with the different specific objectives of the transport studies which carried on specific scope or focusing issues, budget and time matters. And thus, in this study the concepts and logical structure (which comprises economic, social, and environmental issues) of table 2.1 are used, but some of the indicators are omitted in analysis part of this study due to some reasons which are briefed in the following section (or discussed under the concluding remarks).

## *Concluding remarks*

Performance indicators which are listed below in table 2.2 are the summary of indicators which will be assessed in depth in chapter 4. According to the scope and goals of this study, selected performance indicators will have capacity to reveal the real situation of Addis Ababa and finally helps to recommend plausible solution for the problems. Moreover, due to its comprehensiveness, transport sustainability study could not cover all issues in depth and that might be considered as a drawback of the study. But still it will not result on invalid conclusion of the study, because performance indicators are considered from all /three/ broad economic, social, environmental concerns. For instance, to see /or evaluate/ "affordability" we can use both performance indicators listed in table 2.1 ('Availability and quality of affordable modes' and 'portion of low-income households that spend more than 20% of budgets on transport), however due to lack of necessary data on later performance indicator was omitted. But the point is that either indicators or one of them show negative result, and then we can conclude the transport situation is not affordable to its users.

In general a transport system to be called as sustainable it should pass all evaluation criteria of table 2.1. On the other hand, a transport system that fails to meet performance indicators evaluation might be considered as unsustainable. And thus, the main notion of this study is not only specifically to know whether Addis Ababa's transport system is sustainable or not, rather it is also to know at what status it exists, based on assessment result of selected indicators. Furthermore, specific aspects of transport sustainability will be identified and recommendation to run towards sustainability goals will be done. Therefore, selected transport sustainability indicators of table 2.2 have capacity to achieve the desired objectives of this study.

In table 2.2 summaries of performance indicators and sustainability goals (economic, social and environmental) to reflect intended objective of the study are listed as follow:

| Sustainability goals | Performance indicators |
|---|---|
| ▪ Economic<br>- Economic productivity | Per capita congestion delay |
| - Economic development | Access to education and employment opportunities. |
| - Energy efficiency | Per capita transport energy consumption<br>Per capita use of imported fuels. |
| - Affordability | Availability and quality of affordable modes (walking, cycling, ridesharing and public transport). |
| - Efficient transport operations | Service quality<br>Service delivery unit costs compared with peers. |
| ▪ Social<br>- Equity / fairness | Transport system diversity.<br>Portion of destinations accessible by people with disabilities and low incomes |
| - Safety, security and health | Per capita traffic casualty (injury and death) rates<br>Traveler assault (crime) rates |
| - Community development | Land use mix.<br>Convenience for Walk and bike<br>Quality of road and street environments |
| ▪ Environmental<br>- Prevent air pollution | Per capita emissions of local air pollutants (PM, VOCs, NOx, CO, etc.).<br>Air quality standards and management plans |
| - Traffic noise pollution | Traffic noise levels |

*Table 2.2 summary of performance indicators*

Although using all indicators listed on table 2.1 will result on better output than considering only some selected performance indicators, due to several reasons in this study only some of them were considered to measure status of Addis Ababa transport system and its role to achieve desired goals of economic, social and environmental aspects. The reason (why for) of some of the indicators and goals assessed and the others are not included in this study is due to:

- Time limitation for this study and lack to handle all compressive issues of transport sustainability
- Lack of relevant data to assess some goals based on performance indicators
  For example to assess role of Addis Ababa's transport to realize economic productivity of society, per capita GDP, the way how prioritization of facilities, potion of budgets devoted to transport lacks consistent data and clear information: For instance portion of low-income households that spend more than 20% of budgets on transport couldn't be found and thus it was omitted, lack of reliable data on recent rate of unemployment in Addis Ababa etc are not considered in this study.
- Some were omitted due to their duplication either directly or indirectly in the other goals. For instance under environmental goals, to achieve open space and biodiversity protection the role of transport should consider performance indicators such as 'per capita land devoted to transport facilities', 'support for smart growth development' which both are assessed under sub-topic of

'community development' when assessing quality of roads and street environment, the amount of road density (or land devoted to transport & its role for compact development) were studied. In the same way 'portion of travel by walking and cycling' which mentioned under the safety were covered during studying affordability (availability and quality of affordable modes). Per capita fuel consumption which is stated under the goal environment (protect water quality & minimize hydrological damages) omitted since it was already considered under economic goals (energy efficiency per capita transport energy consumption). And therefore, as possible as this study tried to avoid redundancy of concepts by screening out some of the indicators.

☞ *Sustainable transport system of a city will allow its residents' to live as far as the ability to choose where to live, work, shop and socialize and enhance economic viability, accessibility for all, ecological sustainability, social equity, health and safety. On the other hand to build a sustainable transport system, key stakeholders should develop strategies that enhance sustainable mobility especially providing more travel choices for the disadvantaged. Beside sustainable mobility, enhancing accessibility or the ease of reaching destination with reasonable travel costs is also very crucial point. Transport planning activities should cooperate with spatial planning and other sectors to realize its sustainability. Encouraging non-motorized modes of transportation, increasing public transport system capacity in a way to limit demand to private car ownership, integrated planning, efficient land and other resource use, education and public participation (allowing different social groups to express their views about sustainable transport system development), consensus buildings through networking, increasing individual and community responsibility are some of the basic notions to enhance transport sustainability.*

# 3. STUDY AREA

## 3.1 Ethiopia profile

Ethiopia is located in the Horn of Africa and is bordered on the north and northeast by Eritrea, on the east by Djibouti and Somalia, on the south by Kenya, and on the west and southwest by Sudan. Ethiopia, with a population of 82,101,998 (CSA 2011), is the second-most populous country in Africa and the tenth-largest by area, with its 1.1 million-sq.km. The population is growing at a rate of 2.92 per annum. Moreover, one of the world's oldest civilizations, with more than 3000 years of history (Tolon 2008).


*Map3. 1 Map of Ethiopia*

Although Ethiopia has been one of the world's poorest countries, in recent years Ethiopia is one of the fastest growing economies in Africa (World Bank, 2010). According to National Accounts Statistics of Ethiopia, (MOFED, 2010) report, over the last six consecutive years, i.e. during 2005-2010 the economy has registered rapid growth. Accordingly, in this period the annual average growth rate of GDP was 11.5 Percent. The agriculture, industry and service sectors' annual average growth was 7.6, 10.6 and 13 percent respectively. National economy relies mainly on the agricultural sector that depends on rainfall. Droughts are recurrent and have affected millions of people in last decades. And therefore, the performance of the national economy fluctuates considerably with changes in weather conditions, which is very common phenomenon for agricultural based economies.

Nevertheless, its robust growth performance and considerable development gains from 2003 to 2007 also faces huge threat during 2008 and 2010 with the emergence of twin macroeconomic challenges of high inflation and a difficult balance of payments situation. In an effort to control inflation and the rising cost of living, the government has been taking various measures including putting price caps on selected goods and increasing the salary of civil servants by 35-39 percent. According to MoFED, this year's (2011) sharp increase in inflation is due to the result of global food and fuel price hike. In addition the price of oil had risen due to the current unrest in the Middle East and when that problem is solved, the price would expect to go down. In any ways it is here clear that, impact of oil dependent transport system and its effect on overall economic activities of the country is highly visible.

An estimated fleet of 170,000 vehicles (2005/06 record) provides transport services in Ethiopia resulting in current rate of motorization of 2.2 vehicles per 1000 people (ERA 2005). The level of motorization is still low compared to current level in Kenya of 18 vehicles/1000 people. As a result, non motorized transport mode is the predominant in rural areas, with motorized vehicles used only for long distance freight/passenger services. According to ERA report, at an average rate of motorization of 8.8% over the 1999-2005 years takes place, and the level estimated only to reach 2.8 vehicles per 1000 people in 2009. Traffic flows on the main network as of 2004 are high with 26 percent of the main network having an average daily traffic greater than 500 vehicles, 59 percent between 500 & 100 vehicles, and the rest 15% less than 100 vehicles. Composite ERA traffic data series for main road sections indicated rapid traffic growth rate of an average of 11.4% per annum over the period 1990 – 2004, considerably above forecast levels and doubling the trend growth rate of GDP of about 6.0%. The most striking feature is the continuing increase in total vehicle kilometers traveled particularly for heavy vehicles. This high rate of traffic growth is supported by data on high fuel consumption.

According to national metrological survey result, the transport sector is a major user of fossil fuel in the country and accounts above 50% of the total fuel consumption (National Meteorological Services Agency 2001). The volume of fuel consumed by road transport vehicles in Ethiopia, which forms the grater share with such low level of vehicular travel as compared to other countries, indicates that the type of vehicles used are dominantly not fuel efficient vehicles. As it was briefed above Ethiopia's economy is highly linked with agricultural productions and distributions, therefore it needs favorable transportation system to mobilize productions and producers from rural to urban or vice-versa and to other relevant market centers. However, the region to region, urban to urban, urban to rural integration is still at a low level. And thus, physical transport integration of Ethiopia with other neighboring countries is also very poor. Moreover, weak road coverage let the predominant rural settlements to remain in isolation from one another and which in turn cause low economic activity. In general physical integration through road network is currently at weak level, on the other hand all these together have constrained fast growth process and compounded the poverty problem, making it a vicious circle.

In the early 1990s, Ethiopia has 23,000km of road, 75 percent of these were rated as in poor condition (Tolon 2008). Later on the government planned three phased road sector development program (RSDP, 1$^{st}$ phase accomplished between 1997-2002) to improve the main road network coverage. According to Transport and the millennium development goals in Africa (2005) study result, in Ethiopia the network wide share of roads in good condition was raised from a very low 18% (which had large impact on vehicle operating costs) in 1995 to 29% in 2002, at the end of the first phase of the Road Sector Development Program, and 37% in 2005, that is on the way to the 2007 target of 45%. The long-term plan that ERA would like to follow, believing it essential to the country's fulfillment of millennium development goal 1 (i.e. Eradication of extreme poverty and hunger), would raise the share of roads in good condition to about 70% (87% of the federal network and 52% for rural roads) by 2015, while at the same time doubling road density from present half-kilometer (all types of road combined) per 1,000 population to about one kilometer.

Network expansion has been done on the bases of regional integration, linking potentially agricultural areas to the market centers and facilitating mobility in rural areas as a strategy. Moreover the government of Ethiopia has launched a new multi-sectoral five-year plan (2010/11-2014/15), called the Growth and Transformation Plan (GTP), which is geared towards fostering broad-based development in a sustainable manner to achieve the MDGs. Over the next five years, the GTP envisions a major leap in terms of not only economic structure and income levels but also the level of social indicators (MOFED 2010). The plan seeks to double the current GDP with an expected yearly economic growth of a minimum 11 percent and high scenario of 14.9 percent, including doubling the agricultural production of the country by the end of 2014/15. The plan seeks to increase access to electricity coverage from 41 percent to 100 percent and total access to safe water coverage from 68.5 percent to 98.5 percent. The main targets in transport sectors that are expected to be meet by GTP at the end of the planning period (2014/15) are summarized in the following table 3.1:

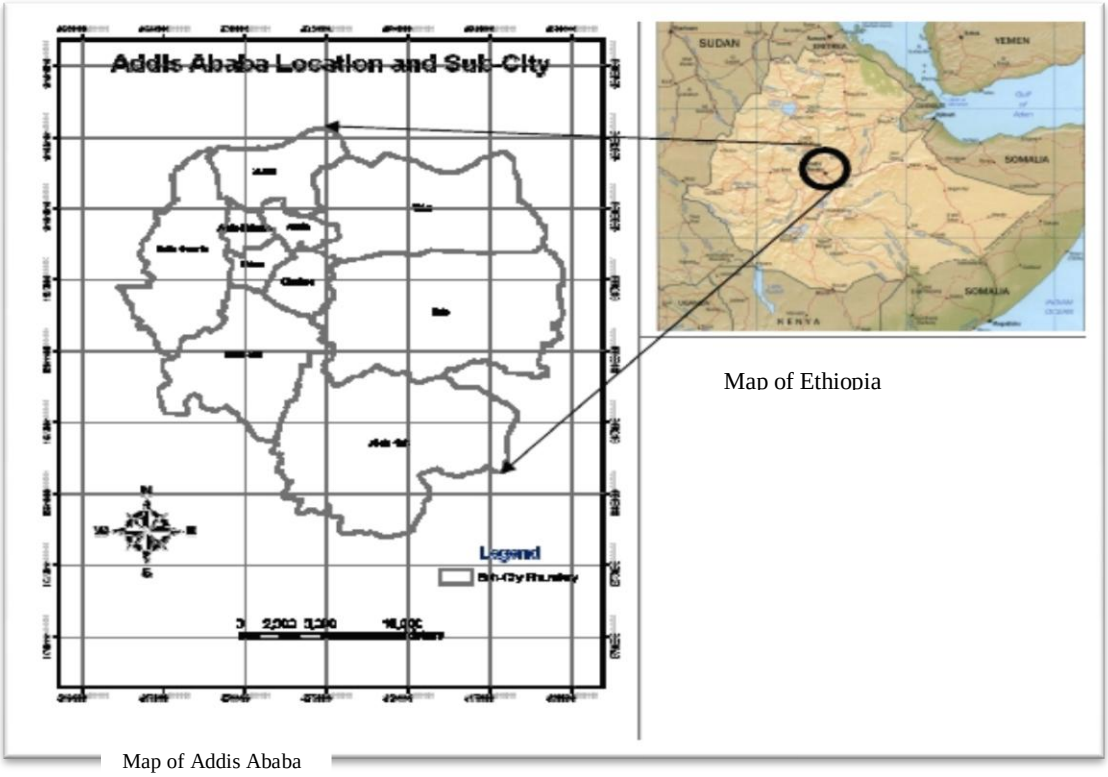
| Sector/indicator | Baseline 2009/10 | Plan target 2014/15 |
|---|---|---|
| Infrastructure development | | |
| Roads | | |
| Roads network (km) | 49,000 | 136,000 |
| Average Time taken to all-weather road (hours) | 3.7 | 1.7 |
| Road density (km/1000km2) | 44.5 | 123.7 |
| Road coverage (km/1000 population) | 0.64 | 1.54 |
| Roads in Acceptable conditions (%) | 81 | 86.7 |
| Proportion of area further than 5 km from all weather roads (%) | 64 | 29 |
| Rail way | | |
| Rail way network (km) | - (currently there is no functional rail way) | 2000 |

*Table 3.1 Infrastructure GTP target (Source: adopted MOFED 2010)*

Addis Ababa's geographic location being at the center of Ethiopia, combined with the lack of development efforts in other urban centers, has given the capital the majority of the social and economic infrastructure in the country (UN HABITAT 2007). As it is seen from the Federal government plan the main intention is to promote mobility within the country to boost economic activities. Moreover, most of huge infrastructure development notions either end up or starts from Addis Ababa, the capital of Ethiopia. This may impose an extra negative load on Addis Ababa future development (for instance increase of unemployment rate since a high number of rural-urban migrant come to the city due to its better infrastructure status) and therefore multi-centered infrastructure development notion should be considered as main target.

### *3.2 Addis Ababa's general profile*

Addis Ababa (it means "new flower" in "Amharic language"), is the capital city of Ethiopia, was founded in 1886 by King Menelik II. It is where the African Union (AU) based, and often referred to as "the political capital of Africa", due to its historical, diplomatic and political significance for the continent. It is also a seat of United Nations Economic Commission for Africa (UNECA), many hundreds of embassies, consular representatives and other international organizations seat. Moreover Addis Ababa has great role in whole Ethiopia's economic, social, political and administrative activities.




*Map3. 2 Map of Addis Ababa and Ethiopia*

Addis Ababa recently has no clear and precise operating vehicle fleet number and various data sources are providing slightly different figures , for instance according to global trade (2011), 80% of total country fleet registered in Addis Ababa. The number of vehicles in the city is increasing by 9% for the last five years and a total number of 180,000 vehicles are commuting every day in the city (Addis Ababa municipality 2010) report. And other sources again indicates that, vehicle population in Ethiopia is estimated to be about 250,000 of which over 60 percent are reported to be in Addis Ababa and around the capital. However, all agree that large numbers of fleets are found in Addis Ababa, and the city has worst traffic problems than any cities in the country.

### *3.2.1 Population*

The population projection figures based on the results of National Population and Housing Census of Ethiopia (2007) is about 3million and estimated to increase to 5.56 million by 2020. Even though Addis Ababa is currently experiencing moderate population growths of its history (6.37 in 1976, 3.95 in 1994, etc) in recent pasts. Its annual population growth rate is 3% (Trans Africa 2010). However, currently the city continues to attract 90.000 to 120.000 new residents every year, mainly due to net immigration (UN-Habitat, 2007). The percentage share of the city from the total urban population of a country is 23.1 percent (CSA 2007)

Addis Ababa, facing all challenges those are very common in cities of developing countries, such as high population growth, urbanization and increasing levels of car ownership, which are leading to unsustainable levels of traffic on the existing infrastructure, and at same time an increase in pollution levels.

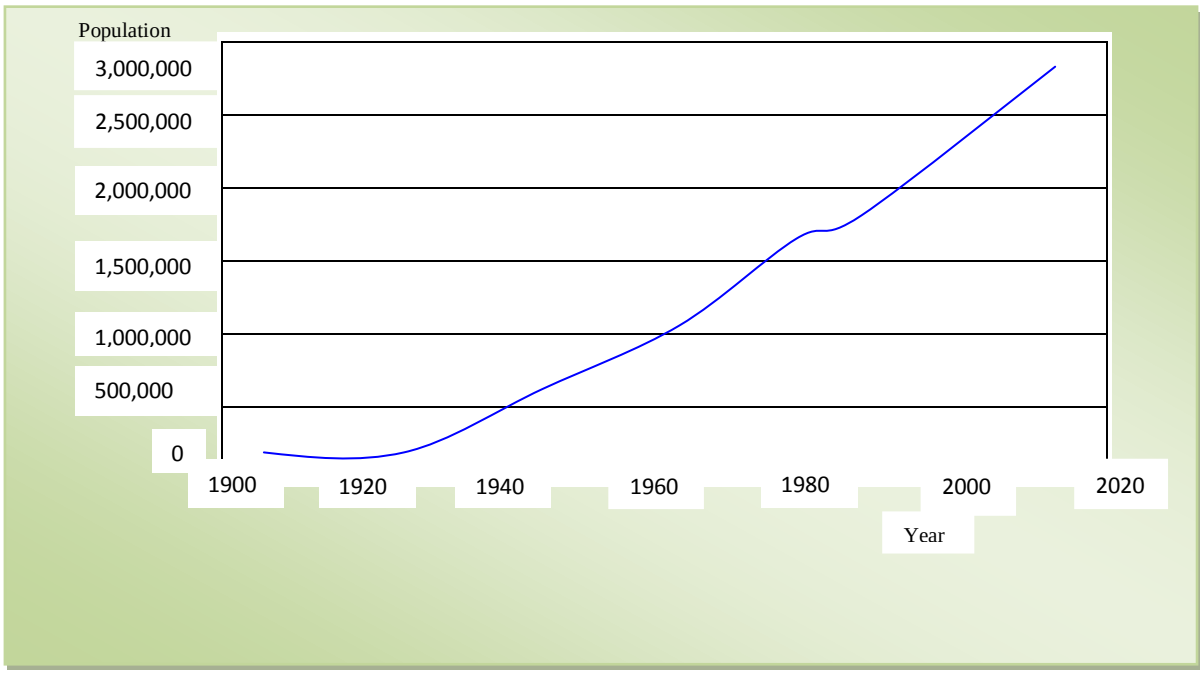
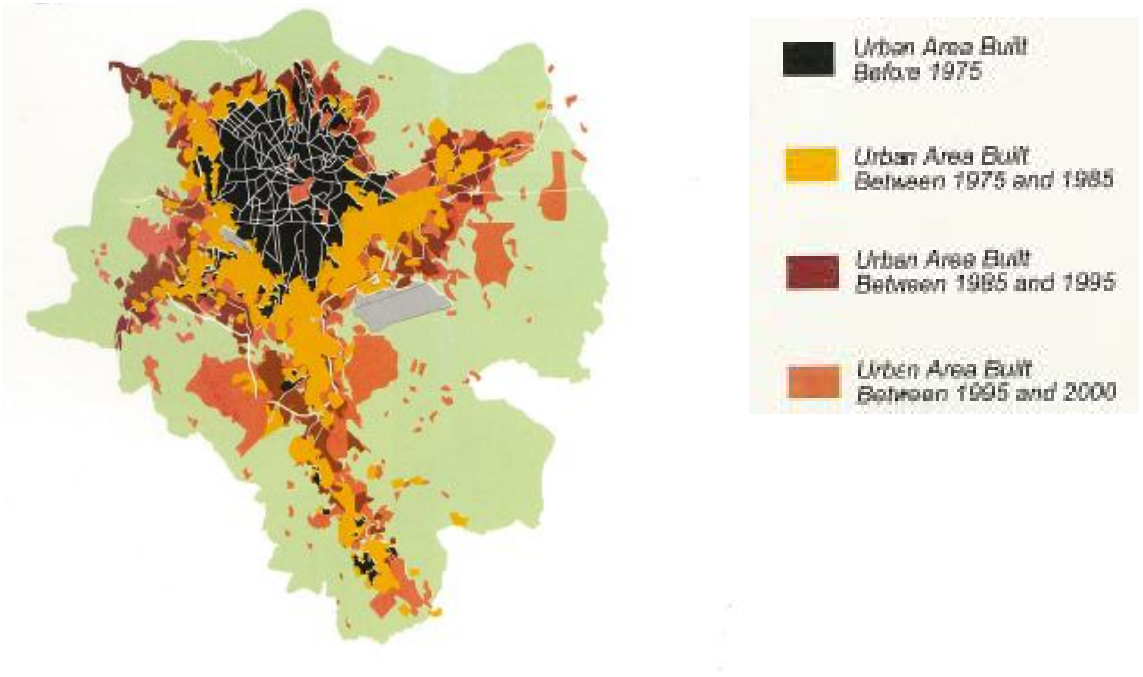



*Figure 3.1 Annual population growth trend of Addis Ababa: (Source: UN-Habitat, 2007)*

Figure 3.1 highlight us how the population growth is dynamic and show very fast growth rate from year to year and which imposes several challenge on development attempt of the city. Especially transport infrastructure growth is not going in a way that to handle the demand of the residents and not going along with population growth in a balanced way. And thus the ability of the city to manage traffic demand associated with these factors is compromised.

### *3.2.2 City development plan*

There was various development and action plans were prepared since 1984, to guide city's development directions and regulate overall growth of the city. In its 127 years history, the city has shown an extensive socio-economic and physical growth. In all those plans transportation concern was one of the basic issues of the planners and stakeholders during their land use planning processes. However, none of the plans were fully implemented as desired during the planning period. According to (Tolon 2008) as an indigenous urban settlement, Addis Ababa initially expanded without any formal planning or control.
According to Tolon, one reason that makes squatter settlements somewhat different in the case of Addis Ababa is that they are not only poverty-driven and most of the squats are mainly middle-class households that have illegally occupied the peripheral areas. On the other hand, squatter settlements in Addis Ababa have rather poor access to basic urban services, including access roads and utilities, due to a combination of their peripheral location and recent establishment. On the other hand, significant number of dwellers is living in dilapidated urban slum of Addis Ababa; even some of those houses are completely inaccessible by car. The lack of the rule of the plan or lacks of enforcement power to implement the plan as desired both in expansion areas and central business districts (CBD) resulted in current sever transport related problems. In general, the city's physical as well as social infrastructure are poorly developed and unevenly distributed over its vast built-up area (UN-Habitat, 2007)




*Map3. 3 Addis Ababa's physical growth trend map between 1975 and 2000 (Source: ORAAMP, 2002)*

The above figure indicates that one of the recent development plans made in 1986 by National Urban Planning Institute (NUPI) and later it was again revised by ORAAMP (Office for the Revision of Addis Ababa Master Plan) in 2002. Presently the period of the second Master plan has been extended up to 2020 and based on it different local development plans are being developed.

### *3.2.3 Institutional set up*

Addis Ababa city administration has three tiers of governments such as:

- A city government of Addis Ababa
- 10 sub-city administrations
- Local administrations called "woreda", they are 116 in number

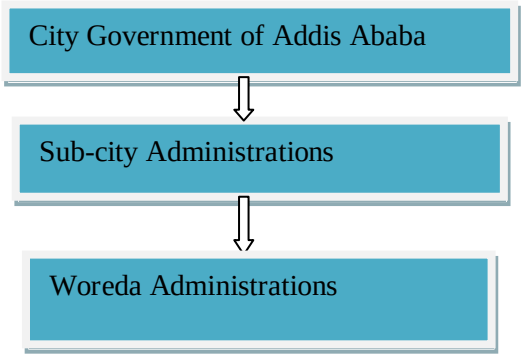



*Fig. 3.2 City administration structure*

The city administration has cabinet with executive power lead by mayor, who is responsible for technical matters. The sub-cities and woreda are organized in a similar fashion and mandated to administer matters in their jurisdiction (UN HABITAT 2008).

Concerning Addis Ababa, public, private and all the rest transport sectors are under the responsibility of city general manager of Addis Ababa and Federal government also take some responsibility of transport authority of Addis Ababa since 2005.

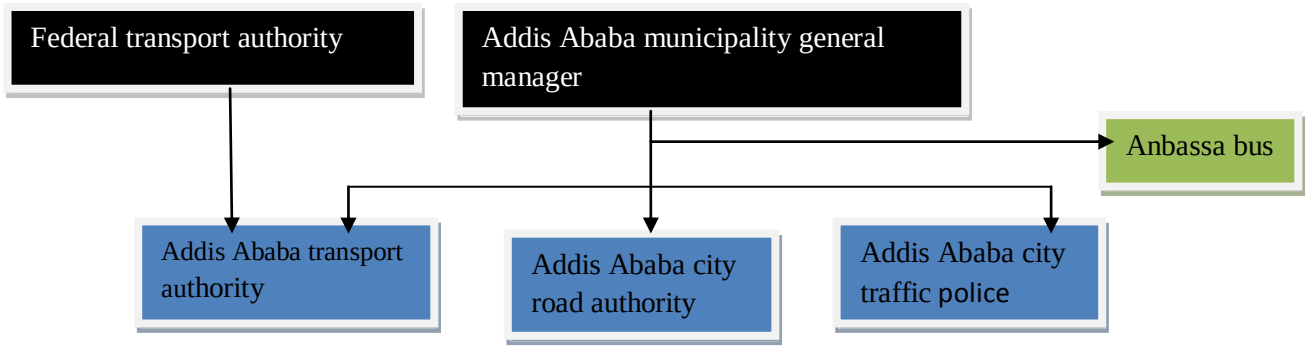



*Fig 3.3 Transport sector institutional set up*

### *3.2.4 Overview of public transport in Addis Ababa*

Addis Ababa's transport system suffers from many inadequacies such as: traffic congestion, poor public transport services and a lack of adequate non-motorized transport infrastructures. Traffic on the roads is increasing from time to time, but shortage of transportation service is a huge problem in most part of the city, mainly in the morning and evening rush hours. The public transport system of Addis Ababa is mainly comprised of the publicly-owned "Anbessa" bus service, "Higer" buses and the privately owned minibus taxi services. Non motorized transport is an important component and consists mainly of walking on unfavorable pedestrian ways or along carriage way exposed to sever traffic accidents.

In Addis Ababa, there are no light rail system, metro, Bus Rapid Transit (BRT) and again it is not common to see bicycle users. Ethio- Djibouti rail line with its terminal at "Leghar" (one of the congested node in Addis Ababa), has a length of 781km and currently it is almost ceasing its function due to various problems like single-track rail built over a century back with aging track and rolling stock coupled with weak management trend. Public transport study carried on Addis Ababa by 'IBIS Transport Consultants Ltd' (2005), estimated that 5% to 17.5% of household's expenditure is on transport.

#### *City bus*

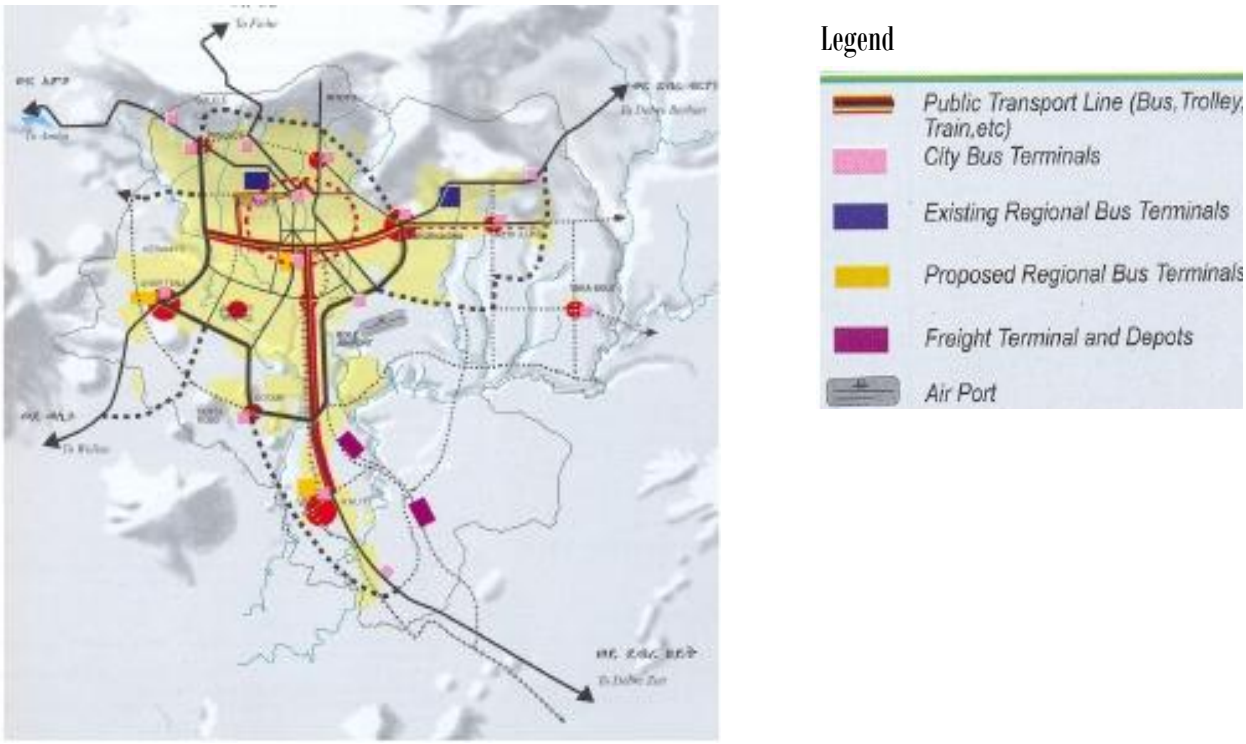
DAF or locally called as 'Anbessa bus' maintains detailed records of its passenger carryings. Allowing for fare evasion, total carryings are estimated at between 650,000 and 700,000 trips per day, equating to over 1,500 passengers per bus per day.

*Figure3.4 Addis Ababa Anbessa bus*

Currently, there are 540 city buses under the enterprise, nearly half of which are out of service due to technical failures. The enterprise operates 93 routes in and around Addis Abeba. Each bus has a capacity for 100 passengers (30 seated and 70 standing).

These buses cover a collective distance of 54,000km daily and provide their services to 1.5 million people (IBIS 2005). IBIS consultants' ltd study indicated that 10.9pc of residents use city buses as compared to the 20.6pc that use taxis. However, the above statistical figures are completely declining at the moment due to various reasons for instance Anbassa's loss of its fleet number, management problems, government subsidy and increase of high cost are among others.

Daily carryings on minibuses and modified taxis are estimated to be of the order of 1.2 million passengers per day, with average load factors on the minibuses and modified taxis of approximately 90% and 83% respectively. Overall, these figures suggest a daily public transport patronage of some 1.9 million passengers, or roughly 0.65 trips per day per person living in the city (IBIS Transport Consultants Ltd' 2005, strategic plan of 2005/2006-2010/2011).




*Map3. 4 Map of public transport routes and Terminals (ORAMP 2002)*

In addition to "Anbasa buses", there are also Midi-buses called "Higer bus" operating in Addis Ababa, which are owned by individual owners. Ethiopian government made a deal to import medium-sized (midi) buses from a Chinese company which manufactures Higer buses, and facilitated the opportunity for 130

individuals and organizations to obtain credit from the Commercial Bank of Ethiopia (CBE) for 500 midi-buses purchase ( reporter newspaper 2010).

*Figure 3.5 Higer buses*

These buses are of two door types; the one-door type bus has twenty-seven seats while the two-door type has thirty-seven seats. However, most of these buses face technical problems as soon as they start their services and owners are complying about its lack of technical quality which result on high maintenance cost, and that limit them to repay bank's loan. In addition, the buyers, reasoning out that as they were unable to pay their monthly commitments due to the minimum transport tariff set by the government and the increasing cost of fuel. According to the reporter newspaper (2010), bilateral agreement made with the bank, the borrowers must repay their loan in five years after a grace period agreed upon in the loan agreement (borrowers have to pay 5000 Ethiopian birr every month). But significant number of borrowers fails to pay that much of money per month according to their previous agreement and currently the bank is exercising its right to foreclose the property it holds as collateral. Moreover, the Commercial Bank of Ethiopia (CBE) has announced the auction of over 100 public HIGER midi-buses imported through loan, as buyers have defaulted on installments (capital newspaper 2011). On the other hand this has its own great and direct negative impact on public transportation system of Addis Ababa.

### *Minibus /Taxi/*

Public transport study carried on Africa, by UITP (2008) indicates that, throughout the continent, public transport is dominated by the operations of the 'disorganized' informal sector (i.e. market- based, unregulated, low capacity service offers). The dominance of these services hampers economic development and reduces the quality of life for citizens as the large number of vehicles required to meet demand causes congestion and parking issues and, mainly citizens suffer with high levels of local associated pollution and low levels of security and safety. It is exactly similar with what is going on Addis Ababa public transport service too, for instance the city's white and blue colored minibuses, "Higer" buses and small taxis (commonly called a "Wuyiyt") has no centralized route and they are unregulated.

However, currently there is an attempt of taxi zoning rules which delimit minibus drivers to work only on specific routes. And to create fair services in all areas, prevent operators from cutting long routes short to make more money, and enable passengers to pay the appropriate fares the implementation process face serious challenges, detail about taxi issues are said in analysis section. On conventional Addis Ababa minibus services, their route network has developed over time to link fixed terminals on an ad hoc basis as demand has been identified and therefore, the owners/drivers of minibus taxi determine the distance and thus cut the trips into two or three short distances in order to maximize their gain usually at peak hours.

*Figure3.6 Addis Ababa blue colure minibuses*

In general minibuses and taxi services of Addis Ababa has significant management problems, and they are one of the major causes for traffic accident due to lack of safety. They have a bad habit of increasing their authorized fares illegally at different occasions and minimize variable costs (notably fuel), which result on high cost of customers especially for urban poor. Currently there is an indication that transport authorities are making efforts to alleviate the problem in short and long term plans, for instance future transport plan of the city highlights that tangible activities are taking place to realize mass transportation, including an electric railway and promoting private companies to invest on public transportation sector.

The spatial, environmental and socio-economic condition of Addis Ababa City in terms of public transport, in general, is by far behind the requirements of sustainable transpiration system. In this research later on we focus on some of the main transport sustainability indicators. And thus the following chapter will give us clear situational analysis of transport system in Addis Ababa, which is fundamental to sustain the livelihood of the city, especially for urban poor.

# 4. SITUATIONAL ANALYSIS OF URBAN TRANSPORT IN ADDIS ABABA

The major focus of this chapter will be evaluation and analysis of sustainable transport systems' accessibility/mobility in Addis Ababa's situations, based on indicators of transport sustainability. A set of performance indicators of transport sustainability was discussed in detail in chapter two. And here only some of (see section 2.4.7 & concluding remarks to know why some of them omitted) sustainability indicators are used to measure Addis Ababa's transport situation/status in terms of social, economic and environment concerns.

The Addis Ababa Master Plan (2001 – 2010) has adopted the vision of "affordable transport, enhanced access and mobility." It describes its goal as "to plan, develop, operate and manage urban transport systems" with the following elements:

- Adequate in capacity.
- Appropriate in form and structure.
- Modern in technology.
- Environmentally friendly.
- Affordable in costs.
- Sustainable in the long range.

However, Addis Ababa Master Plan has no integrated sustainable transport strategy. And thus the following sub-sections will assess and brief what the current situation is really looks like in relation to the development plan visions and basic transport sustainability performance indicators criteria which are listed in section 2.4.8. Moreover, Addis Ababa's transport systems' role and capacity to promote various economic goals, social goals and environmental goals respectively were assessed systematically based on the available data.

## 4.1 Economic goals

### 4.1.1 Economic productivity

Obviously, any urban area's economic productivity is highly dependent on its transport system's well functioning, and thus it is either affected or become beneficiary from transportation. In this regards, one of productivity performance measuring indicator is level of congestion of that city.

Congestion is neither a new phenomenon nor only a role effect of automobile in Addis Ababa. As it was briefed before, increase in number of vehicles versus population growth rate in Addis has no direct relationships. However congestion is occurring in Addis Ababa not due to the existence of number of vehicles rather it occurs due to inappropriate traffic management, lack of different modes of transports, inappropriate road using habit, crimes, on street parking, due to less density of road, unfair service distribution. And thus all these result on a remarkable amount of congestion occurrence in Addis Ababa especially at city centers and main roads of business corridors.

Many of the traffic congestions and road safety problems in Addis Ababa attributed to inefficient use of road networks, weak enforcement capability and poor design of roads. The following photograph is an example of some of the overcrowded transport routes in Addis Ababa, inappropriate walkways,

disorganized traffic flow; on-street parking is also prevalent, which all leads to sever congestion especially at peak hours. The cumulative result has negative role in economic productivity of individuals and city at large.

*Figure 4.1 disorganised traffic flow*

Different studies show that minibuses now account for 23% of all motorized traffic in Addis Ababa, causing a significant amount of congestion particularly at peak hours.

### 4.1.2 Economic development

Another role of transport for economic development of the city could be assessed taking an indicator 'access to education and employments opportunities' as measuring tool. In Addis Ababa almost all higher education's centers are concentrated either at the city center or along main roads where public transport is accessible. On the other hand slum areas and urban fringes are suffering due to lack of education and other employments opportunities. It is well known fact that if an area lacks to have various social services mix and transport services, it will also become economically inactive or dead ends.

### 4.1.3 Energy efficiency

Ethiopia is one of the countries without its own source of oil and thus depends highly on imported petroleum products. Energy efficiency has significant role in economic development of country like Ethiopia who entirely depends on imported fuel. One of the good mechanisms to evaluate a cities or countries whether it is consuming energy efficiently or extravagantly is using indicators like ' per capita transport energy consumption and per capita use of imported fuels'. And therefore, fuel consumption data in table 2.1 indicates that Addis Ababa consumes high energy.

| Type of fuel | Ethiopia | | Addis Ababa | |
|---|---|---|---|---|
| | 2002-2007(yr) | 1997-2007(yr) | 2002-2007(yr) | 1997-2007(yr) |
| Benzene | 4.6% annual growth rate | 1.62% growth rate | 29% annual growth rate | 7.6% annual growth rate |
| Naphthalene | 8.8% annual growth rate | 2.41% growth rate | 16% annual growth rate | 10% annual growth rate |

*Table: 4.1 Fuel consumption trends in the county and Addis Ababa (Source: Ethiopian Petroleum Company 2005)*

Addis Ababa consumes 60% of the country's Benzene imported and 18% of the Naphthalene, which indicates that, there are a significant number of small motorized vehicles that consumes much more fuel per passenger per kilometer.

It is estimated that two million metric tons of fuel are consumed in a year by motor vehicles circulating in the metropolitan area and, from this volume of fuel, 90% corresponds to a complete combustion producing Co2. This means that the remaining 10%, or 200 million kg, corresponds to products contaminating the environment like CO, NO2 and SO2. Air pollution in Addis Ababa is becoming an issue with visible dense smog in the city throughout the day, affecting the respiratory organs of its inhabitants as well as plants. Mass transportation's share of air pollution is less than that of the other modes of transportation proportionally.

In general, city of Addis Ababa by no means could be considered as efficient transport energy consuming city. The main reasons which could be seen as reason for high consumption of energy include old model vehicles fleets, and existence of high number of small sized (taxi, minibuses and picks) vehicles which are very common to most of sub-Saharan cities.

### 4.1.4 Affordability

In Addis Ababa minibus, midi-buses, and city buses are the major means of public transportations. And their tariffs and fares are regulated by the government periodically based on global fuel price changes. The transportation service fare that "Anbessa" charging is one of the lowest, and this has made it the first and most preferred means of urban transportation in terms of cost for the majority of the metropolitan inhabitants (or urban poor), compared to the other modes of public transport.

The actual levels of authorized fares in Addis Ababa vary widely from one means of transport to the other and it will change occasionally based on the world market price of fuel. For instance, a city bus has a flat fare for each transport route but varies per distance travelled. Approved fares for minibuses are related to the length of the trip within bands of kilometers run (for example 0-2 km costs 1.10 Birr, 2-4km costs 2.25 Ethiopian birr & etc). Let us see the following current fares and authorized minibus tariffs (as of January 2011):

- **shortest distance: 1.10 ETB** *(e.g. Minibuses route origin at or vice-versa 'Piazza' to 'Arate kilo' or 'Kebena' to 'Megenagna' that is within 0-2km range which costs 1.10ETB)*
- **Next stage to short distance: 2.25 ETB** *(e.g. Minibuses route origin at or vice-versa 'legahare' through 'mexico' 'Torehayeloche' destination, which costs 2.25ETB*)
- **The one after that: 3.00 ETB** *(minibus routes like: 'Stadium' – through 'Hayahulet' – 'Megenagna' destination)*
- **And the next: 3.20 ETB** (Note that since this data collection there are significant fuel price hike and probably a hike in minibus fares now in Addis Ababa also expected)

For instance, if we take someone who is living in an area called "piazza" and work at "Megenagna", let us assume he or she use usually a minibus as means of transport through route (origin "Piazza" – "Arete killo" – "Kebena" – "Meganegna" destination). He/She has to pay 2.25ETB when a taxi says (conductor call) to only "Megenagna"). However, when taxi says he is only going to "Arate kilo" the customer has to pay 1.10 ETB from Piazza to Arate killo, and then when he says he is continuing to "Kebena" the customer has to pay again 1.10ETB, and finally if the same taxi is going from there to "megenaga" he has

to pay 1.10 ETB that cost total 3.30ETB for a single way travel (remember if the customer go through directly from "piazza" to "Megenagna" without any break the total authorized fare is 2.25ETB). For a trip he or she will pay totally 6.60ETB if she or he only makes a single trip per day. In such a way, a person spent in normal tariff 4.50 ETB (2*2.25) for a trip to "Magenagna" to "Piazza" or vice versa, but in informal (when route broken ostensibly) way, the customer will pay 6.60ETB(3*1.10ETB) for a trip. On the other hand, only considering week days travel in a month there are 20 week days and therefore he/she has to pay 90ETB per month (20*4.50ETB) in normal tariff and 132ETB per month (20*6.60ETB). Therefore, the customer will pay a difference of 42 ETB extra per month. For a large family that has limited income source cost of living will raise quite a bit and/or it is unaffordable means of transportation for urban poor.

However, the setting of the band limits has resulted on certain anomalies in fare rates. Drivers (operators) artificially break their routes (especially at peak hours) to force passengers to pay two higher-rated fares go halfway down a route and once there, they continue the rest of the way or change to other short routes. Why drivers do that? What will be its effect on passengers' day to day routine activities? Drivers when they are asked the prior question usually respond: despite the fact that you are already paying more to compensate for the fuel price hike, and tell you as he's still not making enough money. And therefore, to check whether there was truth to this claim or not, let us see the Addis Ababa realities from different angles based on the following statistical data:

- A liter of fuel costs 15 Birr (as of January 2011)
- The average minibus can manage 8kms/liter.
- A minibus legally carries 12 passengers.
- A minibus averages 10 trips a day and 20 working days a month (counting only week days).

| *Revenue and profit* | *Authorized fare rates* | *Informal (unofficial) fares raising by drivers(i.e. when drivers artificially break normal route length in to short distances that costs 1.10ETB each)* |
|---|---|---|
| *Revenue from one trip* | *38.40 Birr (12 passengers if they travel a route that costs 3.2 ETB)* | *52.80 Birr (12 passengers will be forced to pay 4.4ETB each)* |
| *Revenue from round trip* | *76.80 Birr (38.40×2)* | *105.6ETB (52.80×2)* |
| *Daily revenue (assume a minibus make 10 round trips/day which is very common)* | *768 Birr (72×10)* | *1056Birr (105.6×10)* |
| *Profit (minus 450 for running costs)* | *318 Birr (768-450)* | *606 Birr (1056-450)* |
| *Monthly profit* | *6360 Birr (318×20)* | *12,120 Birr (606×20)* |
| *Annual Profit* | *76320Birr 6360×12)* | *145,440(12120×12)* |

*Table: 4.2 Comparison of authorized fares and informal fare of Addis Ababa minibuses*

Therefore, according to calculation of table 4.2, in a year 69,120 Birr *extra* (145,440 – 76320) profit made by a single taxi by unfairly charging commuters. Moreover, it is possible to extend the calculation and cost analysis of this matter. Let us assume as if there are 30 minibuses on one route they make 69,120×30 (2,073,600ETB) extra profit. And if there are 20 such routes in the city, then the public pays 20×69,120 (1,382,400) ETB extra a year that contributes a lot to overall unfair transport costs of the city.

The calculation has done in Table 4.2 without taking into account extra passengers, and passengers who travel only short distances (exit taxi before reaching last destination of trip & in place of leaving customer there is a probability of new comer who will pay the same price that is extra income for drivers) so that

the taxi actually makes more by transporting more people over a certain distance and weekends (where business is slower than usual).

It is true that fuel costs keep rising, but it is also true that the road transport authorities issue higher official minibus rates every time that happens. The taxi drivers' argument is not fair because official rates have already gone up. Of course there also very insignificant number of Taxi drivers who operates based on authorized fares. Minibus fares levels are about four times those charged by Anbessa buses, for the lengths of trips typically undertaken.

Their route network has developed over time to link fixed terminals on an ad-hoc basis as demand has been identified. However, these routes are then broken down into smaller sections, ostensibly to provide route interchange opportunities. Drivers often use these interchanges, particularly at peak hours, to exploit the authorized fares structure and maximize their incomes.

Besides thinking on how to make all public transport modes affordable for marginalized groups within a city, it is also worth to know major source of Addis Ababa's public transport high costs (except "Anbassa" buses). Public transport costs are directly and/or indirectly related with Addis Ababa's: vehicle costs, fuel prices and consumption, vehicle insurance and vehicle maintenance such as hire purchase, public transport service maintenance, costs of various spare parts, and thus a city transport authority should also critically plan to make these all costs relatively less expensive.

Availability and quality of affordable modes (walking, cycling, ridesharing and public transport) of transport is one of transport system's performance indicator and if a city has a capacity to make sure all residents can afford access to basic (essential) services and activities, then it could be considered as it achieved specific affordability goals.

The modal split in the mid-90s in Addis Ababa was estimated: as pedestrian trips 70%, public transport 26% and cars 4% (Project Appraisal Document of the World Bank, 2003). On the other hand, the result of comparison of only buses with taxis after two years of the above study, this statistical data changed to buses starts to provide 40% of the public transport service in the city, and taxis account for 60% (Ethiopian Roads Authority 2005). And again another study carried on public transport in Addis Ababa by Trans Africa (2010); citing GBA consultants study result estimated the following transport modal share during the peak hours:

- Pedestrians 30%
- Small & collective taxis (private) 25%
- City buses (Anbessa) 35%
- Private vehicles 7%
- Company provided transport 3%

The above modal share studies results show that about 35% of passengers used to use Anbessa" buses for their day to day routine economic and social activities. Furthermore, inadequate public transport services lead pedestrians 30% at peak hour to walk on inappropriate sidewalks without their choice which may constrain active participation of city residents, especially the urban poor in economic activities, as well as limit their access to other services (health, education, market, etc). And on a worst cases walking along some routes (especially some traffic congestion prone routes that has no walkways) result on either sever or minor traffic accidents and/or cause mental discomfort which let them to watch back and forth frequently.

According to study result of Kumar and Barrett (2008) that takes place under the support of World Bank and SSATP, on urban transport in 14 cities of Africa cities including Addis Ababa, show us both large and small buses are most common mode of transport and again minibuses are more prevalent than large buses (except in Addis Ababa and Ouagadougou), which reflecting the difficulties of operating large buses without subsidy. Let us see shares of various modes of transport in use in 14 African cities in the following table;

| Shares of various modes of transport in use in 14 African cities | | | | | | | |
|---|---|---|---|---|---|---|---|
| City | Large buses | Minibuses | Taxi | Motor cycle | Private car | Walk | other |
| Abidjan | 11 | 19 | 29 | 0 | 18 | 22 | 1 |
| Accra | 10 | 52 | 9 | 0 | 13 | 12 | 4 |
| Addis Ababa | 35 | 20 | 5 | 0 | 7 | 30 | 3 |
| Bamako | 1 | 10 | 5 | 56 | 19 | - | 9 |
| Conakry | 1 | 14 | 6 | 0 | 1 | 78 | 0 |
| Dakar | 3 | 76 | 6 | 6 | 11 | - | 1 |
| Dar es salaam | 0 | 61 | 1 | 1 | 10 | 26 | 1 |
| Douala | 10 | - | 13 | 12 | 2 | 60 | 3 |
| Kampala | 0 | 41 | - | 20 | 35 | - | 4 |
| Kigali | 1 | 75 | 10 | 0 | 10 | 5 | 0 |
| Kinshasa | - | - | - | - | - | high | - |
| Lagos | 10 | 75 | 5 | 5 | 5 | high | 0 |
| Nairobi | 7 | 29 | 15 | 2 | - | 47 | 0 |
| Ouagadougou | 8 | 0 | - | 58 | 14 | - | 20 |
| Average | 7 | 30 | 8 | 12 | 12 | 37 | 4 |

*Table 4.3: Shares of various modes of transport in use in 14 African cities*

*Source: Kumar and Barrett (2008)*
*Note: - = not available. Rows may not total to 100 because of rounding*

In general, quantitative data's of 14 cities in Africa indicates that public transport in urban areas is still not in a position to promote sustainable transport development of those cities. Furthermore, it is not capable of helping their residents' economic and social concerned activities. Addis Ababa's "Anbassa" buses are relatively looks supporting urban poor in a better way in this regard, but its service is not yet sustainable due to its high financial subsidy, less number of fleets, worst service quality, management problems and so on reasons.

## *Non-motorized modal share*

Despite a large volume of pedestrians, there are no appropriate walkways over a large length (63%) of the road network. Even a road which is by default with a pedestrian way, it usually accompanied by a drainage system of open ditch (in which both liquid wastes and storm water flow together in some areas) that pollutes an environment and at same time constrain smooth walking too. Moreover, the roads with pedestrian way either it lacks to consider handicapped, children, and aged people special needs or constrained with electric poles, telephone poles, misplaced street trees and for all who prefer to walk (except the roads which are newly constructed this is general fact of Addis Ababa walk ways).

| S/n | Roads Hierarchy | Unit of measur ement | On Left Side | On Right Side | Total |
|---|---|---|---|---|---|
| 1 | Arterial | Km | 73 | 58 | 131 |
| 2 | Sub Arterial | Km | 63 | 57 | 120 |
| 3 | Collector | Km | 55 | 55 | 110 |
| 4 | Local | Km | 13 | 13 | 26 |
| | Total | Km | **204** | **183** | **387** |

*Table 4.4 Pedestrians' walkway (Source: Municipality report 2010)*

Table 4.4 data indicates that a lot has to be done on sidewalks along main roads and it remained us also how difficult is walking in Addis Ababa in relations to current large number of pedestrians. Especially for hand caped, children and aged sections of the society the challenge will be double. On a daily basis, the poor either have to expose themselves to very dangerous walking conditions in search of basic needs, or be stranded in the slums in central business districts. People living in poverty usually travel on foot. The modes used by the most urban poor (walkways) needs serious attention of road designers, planners and governments should have invest on those facilities.

Moreover, walking in general has to get an awareness of sustainable modes of transportation by stakeholders, but in case of Addis Ababa pedestrian facilities did not get a due attention in a way to promote walking. Pedestrians are decreasing from time to time due to several reasons which require serious consideration to encourage and create comfortable environment for walking within a reasonable distances and healthy conditions. Major social service spatial distribution of Addis Ababa also should be considered in terms of transport access too. Unlike other cities in the country such as "Awassa" and "Bahirdar" (well known cities with bike use), cycling is insignificant in Addis Ababa because of topographic inconveniences and however in some areas lack of bike use encouraging situations, and to some extent weak social attitude towards bike use itself. In some areas (or sub-cities) of Addis Ababa promoting bike use is still possible and in this regard good experiences of countries like Netherlands should be exploited.

### *Motorized transport modal share*

Trip by car has the lowest modal share in Addis Ababa, according to municipality report (2010) only 4.7 % of all trips and vehicular trip rate is also low (0.47 per capital). This could be one of the good indications for less affordability of mass transport especially for the majority of the urban poor and increasing pressure on public transport let significant number of people to suffer for each and every trip by other means of transport without their willingness to do so.

*Figure4.2 Inappropriate public transport services (e.g. complex problems at sample bus stops, street marketing etc)*

The above photograph show us, an example of some routes with a multi-faceted problems such as : Anbessa buses, Higer midi-bus, taxi all on the same lane, inadequate and poorly managed bus terminals, insufficient footpaths for pedestrians, unclear traffic signs, non-motorized mode of transport neglected in the design of the urban transport infrastructure, informal market on sides of the street.

## *Buses*

Out of the operational fleets of Anbessa, an average number of 296 units are operating daily, carrying about 310,000 passengers on 93 routes (Trans Africa 2010). Here due to low number of vehicles currently "Anbassa" has decreasing the total sum of passengers traveling per day, for instance in 2005 the number of passengers carried by "Anbassa" buses were very high and 650,000 to 700,000 trips per day traveled. However the public transport demand increases from year to year in an alarming rate with the rate of population growth.

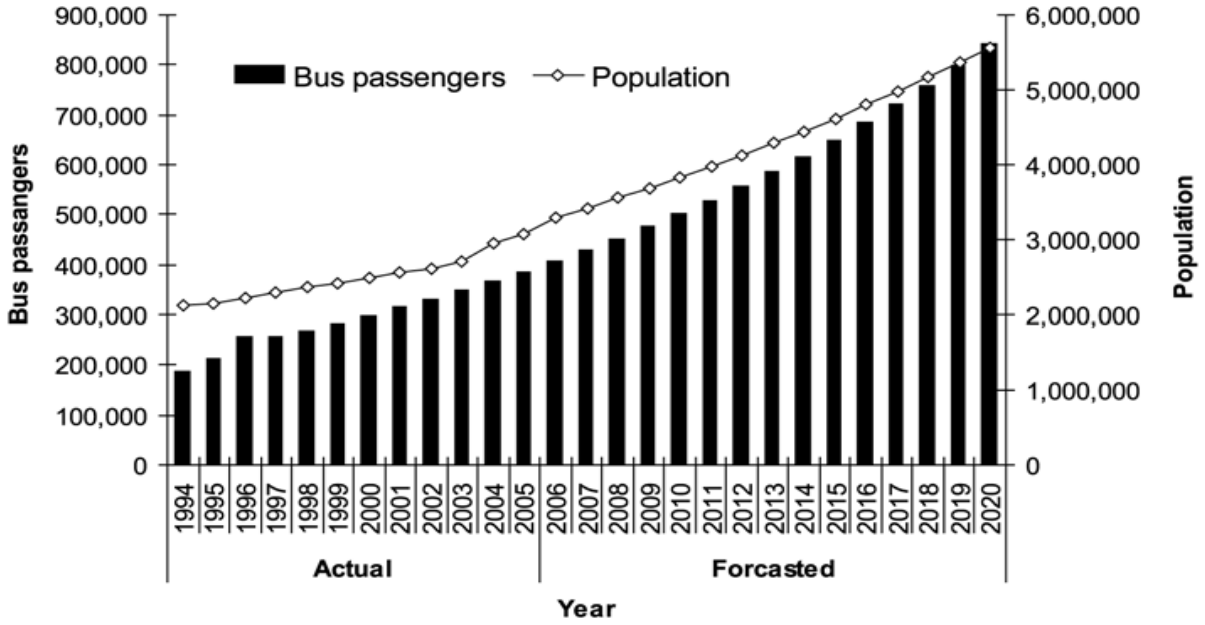



*Fig.4.3 Population and bus passenger's growth (Sources: Mintesnot and Takano, 2007)*

Addis Ababa with regards to public transport, facing three major problems at the same time these are: increasing population (Addis Ababa population growth rate is 3%), physical expansion of the city, and great load on existing public transport services. The bus network coverage is mostly concentrated on the city center and there areas (or localities) with low or no bus network access, where the city is exhibiting trends in urban expansion and residential developments are underway.

Anbessa is unable to make adequate provision for the replacement of its assets (costs) from its operational cash flow, and its business expansion has almost been entirely externally funded. Moreover, a subsidy is paid for each passengers carried just without identifying financial capable, urban poor and other marginalized groups. Addis Ababa city administration, sensing a transport demand-supply gap, as the five year strategic plan (2006/07 to 2010/11) document indicated, private sector engagement has been initiated by investors seeking to provide modern city bus public transport services. Transport authority should plan to strengthen management system of "Anbassa", encourage private sector participation in public transport by different mechanisms. For instance encouraging bus importers making tax free, encouraging bus manufacturing companies to produce it within the country and/or supporting bus structure rebuilding companies to minimize high cost of importing and loss of foreign currency.

## *Higer bus*

The publicly owned Anbessa city bus services enterprise had held an exclusive franchise for urban bus services within the city for a long year and currently there is an attempt to introduce other alternative means of buses such as "Higer" buses. The "Anbessa bus" monopoly of conventional bus services was one of the reasons for private bus companies not to participate in public transport service provision and which limit competitive quality service provision too. Although transport authority is doing great effort to encourage private companies to involve in public transport sector, experience of "Higer" buses is still discouraging. This company is complaining for its incapability on fixed fares public transport market. It seems no competitor has been able to emerge to challenge it. Anbessa's access to subsidy and public investment act as a barrier to any new market entry. However, there is no reason why commercial bus services, operating at a fare above that of the subsidized services, shouldn't be encouraged.

Obviously, the mass transport modes of Addis Ababa have a tremendous advantage over any other modes with respect to the number of passengers carried per mode. To summaries advantages of Anbassa public transport:

- ✓ *Passengers transported:* Anbessa carries 8 times more passengers per km than a minibus in Addis Ababa.
- ✓ *Fuel consumption:* 1.8 times more fuel is needed to carry the same number of passengers by minibus compared to an Anbessa bus.
- ✓ *Transport cost for the users***:** Anbessa city bus services are affordable for the majority of the population and Anbessa's fares are lower than other motorized offers for similar trips.
- ✓ *Congestion***:** Loading capacity per Anbessa city bus is nine times that of minibuses, 25 times that of private taxis and 2.7 times that of collective taxis. This means that a single Anbessa bus can transport the same number of people as nine minibuses, 25 private taxis or 2.7 collective taxis. In addition, each trip made by bus reduces congestion and the total number of vehicles in the street.

On the other hand there are also complaining of customers and disadvantages of "Anbassa" and "Higer" bus users related with its service such as:

- Crowding and overloading is the worst- quality-of service indicator, the bus is often seen jam-packed, its doors barely able to close.
- Lack of facilities, both at terminals and at stops along the route (most of bus stops have no shelter, street chairs etc)
- Low frequency of bus services and hence long waiting times

## *Minibuses and Taxis*

Surveys have shown unacceptable levels of service at peak hours and the inefficient use of road space by low capacity modes of transport. Cars move only 15% of people, while accounting for 60% of vehicles in traffic. However even the minibuses required 23% of all vehicle trips to carry 39% of people, whereas buses carried 45% with only 4.5% of the traffic flow (IBIS transport consultant ltd. 2005).
Of the total 14,083 taxis (both 12 seat types and 4 seat types small taxi) in Addis Ababa around 96% (or 11,806 taxi) are registered and inspected by Addis Ababa transport authority in 2005, the rest are either giving taxi services illegally or out use. The following table show us again how the number of taxi in Addis Abba is growing from time to time and which may need due attention.

| Year | Registered taxis total number | Growth rate (%) |
|---|---|---|
| 1999-2000 | 8266 | - |
| 2000-2001 | 8847 | 7.0 |
| 2001-2002 | 9910 | 12.0 |
| 2002-2003 | 9930 | 0.2 |
| 2003-2004 | 9262 | -6.7 |
| 2004-2005 | 11806 | 27.5 |
| Average | | 8.0 |

*Table 4.5: Registered and inspected taxis for 1999-2005 (Source: Addis Ababa transport authority)*

The 'conductor' hangs from the window and shouts the destination, and service users will get into up until their total number reach 12 persons per minibus. At peak hours customers fight their way (run) into the minibus to avoid excessive waiting for the next minibus. Minibus taxis do not operate to scheduled timetables but follow the practice of full-load dispatching. This can provide a good level of service throughout the day on busy routes, but often results in excessive waiting time in the off-peak period for quieter routes (it is also common to wait long time in some busy routes due to shortage of supply/ minibuses).

*Figure4. 4 Addis Ababa new taxi zoning scheme implementation effort*

In Addis Ababa taxi drivers keep the fares they collect but are responsible for paying fuel costs, conductor's wages, terminals fees, and other incidental fees. Presently, the Addis Ababa Transport Branch Office of the Federal Transport Authority implemented taxi zoning system to regulate the unregulated taxi drivers. It has classified the city into five taxi zoning areas. These are "Tor-Hailoch" (southwest area of the city), "Saris" (southeast), "Bole" (east), "Megenagna" (northeast) and "Asko" (western) edge of the city. As per the new system 239 routes are categorized into five zones and a total of 9,200 minibuses have been registered by transport authority to employ the system (Addis Ababa transport branch office 2011) report. Currently, there are more than 21,000 blue and white mini buses in Addis Ababa and according to the transport authority, all taxis are abide by the rules and procedures of the new zoning system and enforced to post destination signs on top of their vehicles (as shown in the above photo yellow colure destination indicators on top of each taxi). Changing taxis (change of plate code 1) to commercial (code 3) or code 3 to code 1 has been temporarily suspended until further notice by the office of Addis Ababa City Transport Authority in connection to the newly introduced taxi zoning system that was launched on Wednesday, May 11/2011.

On the other hand, introducing the new zoning system to stabilize the network causing varies chaotic situation coupled with the shortages of taxis made suffer the people, negative opinion prevail by drivers, unbalanced minibuses distribution on different zones and which in turn results on few losers drastically and few who benefited much more than their ordinary income. However, the public officials claim that, there are some change resistant people and all negative opinion toward these changes will be solved gradually when the taxi owners and the public realize the importance of it. Ethiopian state owned television interviewed and broadcasted different mixed feelings of the customers on May 11 and most of the customers have positive perception toward intended change rather than the shortage of taxi that they face in some routes.

Basically the aim of the zoning system is to create fair services in all areas, prevent operators from cutting long routes short to make more money, and enable passengers to pay the appropriate fares. The shortcomings of the implementation process were attributed by the general public to the city administration for failing to give sufficient, consistent and detailed information about the zoning system both before and after implementation of the rule.

☞ *The focus of this study is on Addis Ababa transport sustainability but not on specific mode choice which may require in depth data analysis of socioeconomic survey, demographic characteristics study, travel patterns, mode attributes, satisfaction variables, and in depth bus condition analysis, taxi services. The city's poorly developed transport infrastructures discourage environmentally friendly modes of transport. And therefore, the performance indicators (availability and quality of affordable modes i.e. walking, cycling, ridesharing and public transport) of transport sustainability indicates that Addis Ababa's transport service in general could not be categorized under the notions of the provision of sustainable public transport service.*

### 4.1.5 Efficient transport operations

Service quality and service delivery unit costs are among major elements to achieve sustainability goals in terms of economic matters and they are also best performance indicators to measure whether a transport system is performing efficient transport operations or not.

In this regard study conducted on different modes of transport (walk, car, public transport, and taxi) and customers' attitude toward each mode in Addis Ababa (Takano & Mintesnot, 2007, Demelash 2007), show us less than 20% of customers strongly prefer taxi fare and 50% prefer its convenience. Private car is both preferable for its frequency as well as convenience than other modes of transport in Addis Ababa. Public transport service (specifically for middle income groups) is highly dependent on taxis as a mode despite its high fares (taxis are an expensive means of transportation when compared to buses), which are not affordable, particularly for the low-income group or urban poor.

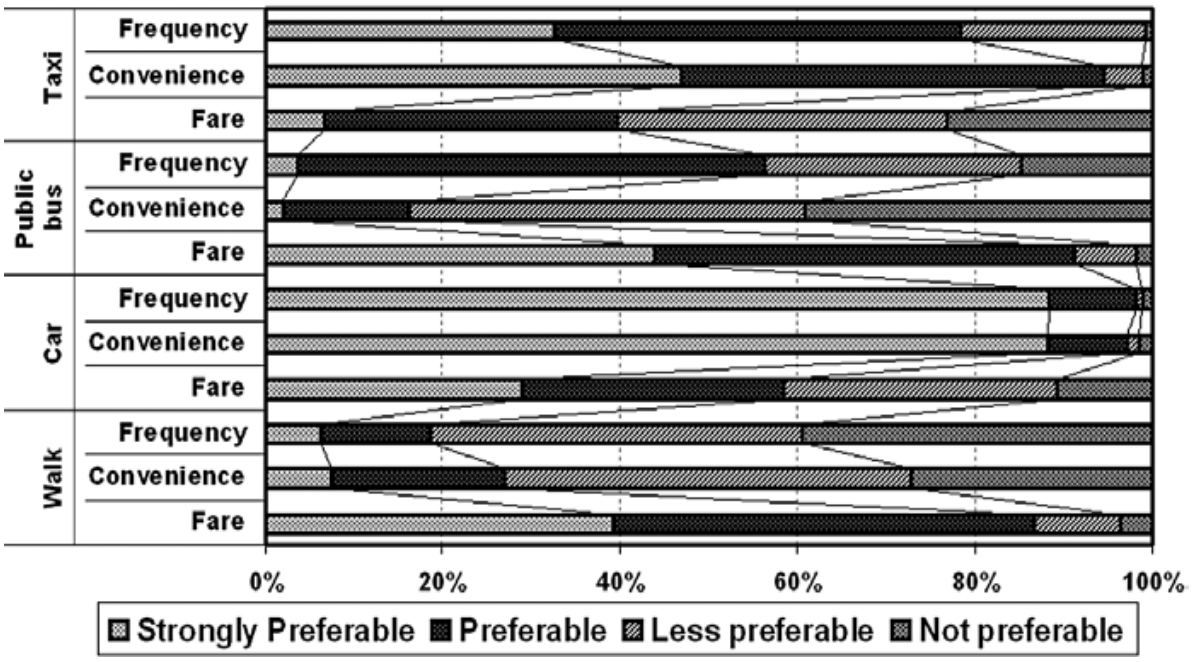



*Figure.4. 5 Attitude toward use of different transport modes (Source: Mintesnot and Takano 2007)*

Poor quality compartment of vehicles, loading extra passengers, unkind treatment of customers by some taxi drivers and their assistant, are some crucial areas of poor service provision, and where significant changes need to be implemented.

Minibuses are expected to fill the gap left by large bus service and to some extent they are doing that task in Addis Ababa. On the other hand, they are contributing a lot for unsustainable public transport service prevalence. For instance let us measure Addis Ababa's minibus transport services based on the following indicators:

- ✓ Road congestion: minibuses now account for 23% of all motorized traffic in Addis Ababa, causing a significant amount of congestion particularly at peak hours.
- ✓ Safety and emissions: most minibuses and taxis are very old, inadequately maintained, and operated for long hour at low speed, both noise (of engine as well as noise of porters "woyala" calls out the taxi's destination) and air pollution is very common problems.
- ✓ Unpredictability of routes, fares (especially in early morning and at evening), and change routes at their own will and thus it is safe to say service of midi-buses and taxi is unreliable.
- ✓ Costs are not affordable for urban poor: Even if they work within the regulated or authorized fares costs of taxis is not affordable for urban poor, and therefore there is no equity.

☞ *It can be concluded that most of the developing country's city challenges in this regard, is particularly significant in Addis Ababa. Taking into account the amount of fuel energy consumed, level of traffic chaos, noise pollution, and low degree of efficiency as far as number of people transported per trip, the shared taxis, "weyeyet" and midi-buses are not sustainable modes of public transportation for Addis Ababa. And therefore, lack of availability of different types of affordable modes of transport, is one of the main factors for existacne of unsustainable transport system.*

## *4.2 Social goals*

### *4.2.1 Equity/fairness*

The term equity is used to refer the fairness in the distribution of goods and service among (groups of individuals) and to the corresponding injustice caused by substantial uncompensated losses (Lichfiels et al., 1975, Friedman 1984) as cited by (Geurs et al, 2001). Basically equity may be maintained either vertically or horizontally. According to horizontal equity notions, "anyone can get what he or she pays for and they pay for what they get". Here the main focus is only on fairness among competitive groups, but does not care about incompetent groups or person due to his/her limitations.

However vertical equity considers incompetent groups of people and costs and benefit is fairly distributed between groups in society. Moreover, spatial equity (distribution of activities in space), social equity (considers age, sex, educational level, household structure, disability or handicap), and economic equity (poor and non-poor). And therefore, vertical equity is one of the means by which public transportation could be facilitated for marginalize groups, to actively involved in socio-economic activities.

A city's transport system equity could be measured based on its transport diversity and portion of destinations accessible by people with disabilities and low incomes. A transport system should be planned in a way that it accommodates and serves all users, including those with disabilities, low incomes, and other constraints. In this regard Addis Ababa's current transport situation is highly problematic. Current Addis Ababa public transport system didn't stratify its customers in to various groups based on socio-economic behavior. In some areas there is no special transport service for an area where private sectors (minibuses, midi buses) sector is not willing to service due to market competition and poor transport infrastructure level which result on spatial exclusion (e.g Addis Ababa peripheries such as 'kolfe' sub-city out skirts, 'nefaselke-lafto kifle keteba' expansion areas etc have no both taxi and bus services). There is an attempt to provide special fare (subsidy) for students in city bus services, but aged without any income, unemployed, extreme poor and others incapable groups have no options of public transportation in Addis Ababa. There are no special public transport services to accommodate the needs of labor groups on time and to overcome peak hour's temporal exclusion.

☞ *In Addis Ababa mobility is highly constrained for marginalized groups of people and there is almost null public transport alternative access for those groups. Thus it is a kind of the fittest can survive and which exclude significant number of the society from various social activities and require urgent measures. From this fact, it is clear that not only poverty complicates mobility, but also transport dysfunctions complicate poverty. The poor do not travel less, rather they travel under less satisfactory conditions beyond reasonable travel time and distance.*

### *4.2.2 Safety, security and health*

Societal safety, traveler's security and health issues are some of the transport sustainability goals and social concerns. To evaluate Addis Ababa's transport system safety and security, per capita traffic causality (injury and death) and traveler's crime rates were assessed in this section as per available data.

Africa at large has bad record of traffic accident and very weak traffic management trend, for instance according to the World Bank Policy Research Working Paper, Kopits and Cropper (2003) estimated costs due to road crashes as a percentage of the Gross National Product (GNP) in most African countries range from about 0.8% in Ethiopia and 1% in South Africa to 2.3% in Zambia and 2.7% in Botswana to almost 5% in Kenya. These data indicate that magnitude of the costs (GNP wastes due to accident) in Africa calling for serious attention toward plausible solutions.

Traffic control activities in Addis Ababa are undertaken mostly by traffic officers in a conventional way, with no advanced techniques such as digital or computerized controlling mechanisms. On the other hand the level of traffic risk is increasing from time to time which calls for emergent measures has to be taken to reduce accidents.

By the target date of 2015, all eight millennium development goals, ranging from halving extreme poverty to halting the spread of HIV/AIDS and ensuring environmental sustainability which also focus on transport matters, shall be accomplished. According WHO (2006) report, traffic is the ninth biggest killer in the world and is predicted to become the third by 2020. One of the UN millennium development goal 7 (that is environmental sustainability) basic targets is reducing rate of road accident fatalities by half in 2015 all over the world.

Ethiopia has worst record of car accident fatalities of 155/10,000 motor vehicles compared to 60/10,000 motor vehicles in Kenya and 17/10,000 motor vehicles in South Africa, ranking among the highest in Africa (ERA 2006). According to study carried on Addis Ababa traffic accidents, 1% of the total traffic accidents caused due to poor road designs. Moreover, Ethiopia has some of the most dangerous roads in the world – with death rates one hundred and twenty times higher than in the UK and almost four times worse than neighboring Kenya (JECCDO 2008).

According to Addis Ababa Transport police Office (2011) report, more than three hundred people die of car accidents in the capital and injure thousands every year. And again, the study conducted on the cost of road accidents in the capital and elsewhere in the country revealed that road accidents in the capital account for 65% total accidents occurred in the country. As regards to the proportion of the victims, 82.6% occurred on pedestrians with the remaining 14.51 and 3.42% accident shared by the passengers and drivers respectively. The damage to property caused by these accidents which claimed over 3065 lives-leaving injuries aside- over the last ten years- amounts to more than 200 million Birr (ETB is local currency, 1Euro= 24 ETB).

The main reason for high prevalence of accidents occurring in Addis Ababa is due to: lack of awareness about basic road traffic rules and regulations by the residents-pedestrians, incompetent cars and drivers, including poorly constructed roads in the capital, lack of appropriate sidewalk ways on most of the roads, poor conditions of cars. In Addis Ababa the fleet age study indicates that the minibus taxies are more than 15 years old and most of them are imported second hand vehicles (Trans Africa 2010). In addition, inappropriate use of zebra crosses, careless use of roads, passing through prohibited roads, and failure to realize it is safer to walk facing the vehicle, instead of having to look back for approaching car behind, all contributed to the high rate of the accidents.

Fig 4.6 & 4.7 clearly show severity of traffic accident that cause death and damage on property within the year of 1996-2008.

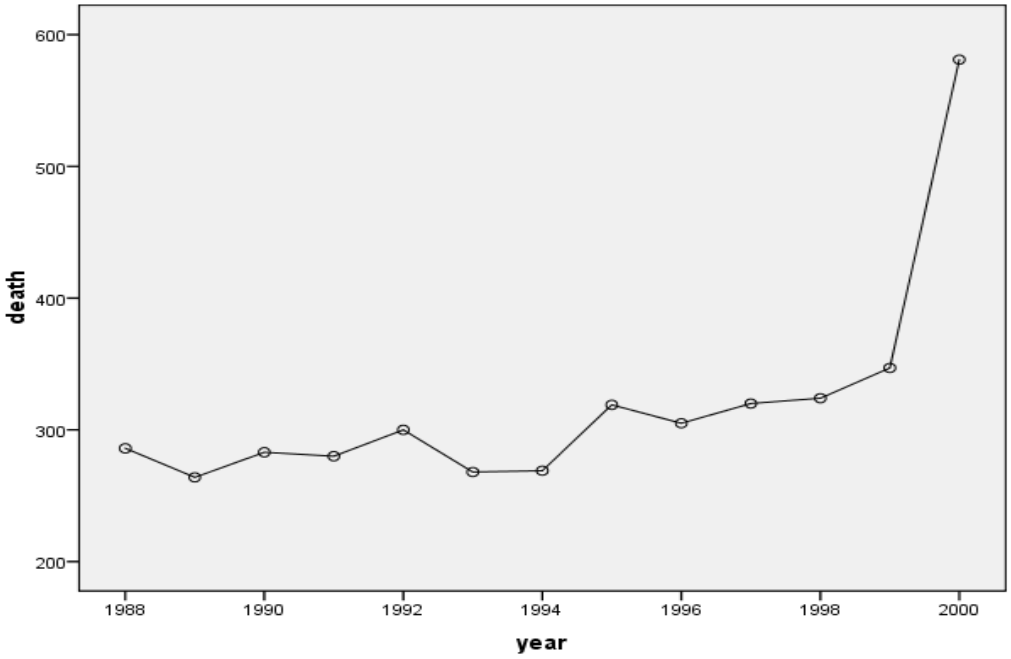



*Fig: 4. 6 Death occurred due to traffic accident in Addis Ababa within the year of 1996-2008 (Source: Addis Ababa traffic police office, 2008)*


*Fig.4.7 Property damage record per Birr wit in 1996-2008 (source: Addis Ababa police traffic accident record data)*

The average death registered in the above specified period of time is 319 with a standard deviation of 83. Data from the Addis Ababa traffic police office shows that the number of road accidents occurred in

2008/2009 were registered as a maximum, with a property damage of estimated 29,003,041 Ethiopian Birr and 581 deaths of people. Moreover, the total number of accidents registered in 2008/2009 was 7,523 accidents in number and out of these number of accidents private cars causes 2010 accidents. Commercial station wagon & pickup types of vehicles take the second place that is 1,740 accidents, heavy trucks, private taxis, minibus, Anbassa bus, collective taxis and others causes 719, 1,174, 329, 141, 639, 771 accidents respectively.

'Anbessa' city buses have better records in terms of road safety in contrast to private cars. 'Anbassa' buses have a scheduled and regulated time to complete a trip and to start from and arrive at their origin and destination. Moreover, it also guides the operations with a predetermined travelling speed and that might have played significant role for its less accident records.

The traffic accident record showed on the above figures 4.6 & 4.7 reveals that there is an average increasing trend of traffic accidents both on human life and property damage from year to year. An estimated 29,003,041birr or 1,261,001.78Euro property damage was registered in 2008 in Addis Ababa which is significant amount of unnecessary cost for such a developing city.

☞ *Severity of the security problems in Addis Ababa is alarming loudly for some means of solution. Both fatalities and serious injuries records indicates that the city is at its risk level and require urgent traffic management process re-engineering and needs advanced techniques in order to minimize traffic accidents. And moreover, various alternative scenarios have to be developed which may brought measurable and actionable recommendations that help and could influence decision maker's view in strategic planning and on their political decisions too. Fig 4.6 & 4.7 statistical data's show us per capita traffic injury and crime rates are growing from one time to the other in an alarming rate which also need partnership of stakeholders to play a significant role in raising public awareness, demand new and compressive strategy to combat the problem, urge modern traffic management system development. Furthermore, in most cases accident cause, accident type, poor driver's behavior and attitude, road surface type, road condition, vehicle type, and traffic light condition all are the main variables on which domain of experts agreed up on it, where significant measure has to be taken in Addis Ababa. A transport system that is not safe, and full of various risks, by no means could be sustainable. Moreover, among the main factors which affect transport sustainability/mobility in Addis Ababa, weak traffic management practice is far more known.*

### 4.2.3 Community development

Transport systems operation quality have great role in community development (creating social tie) among different groups of people. To measure transport systems' role in community development we will use indicators which are briefed in section 2.8 such as: land use mixture, convenience for walk and bike, quality of road and street environments.

Urban population mixture in Addis Ababa has a trend of heterogeneous compositions, which consists of dissimilar or diverse ingredients (different tribe's composition, religion, age, sex, culture, language, level of education, income level etc) or constituent. On the other hand current transportation facilities and services seem do not promoting and maintaining this reality.

### ❖ Land use mix

Land use mix is one of the city's sustainable transport system performance indicators. Distributing social service in a distance where accessible for majority of societies is also good mechanism to realize social tie and spatial equity for services.
About 54% of the area of Addis Ababa is built upon. Of this, 64% is devoted to residential use while 18%, 10% and 8% are used for public, commercial and industrial uses respectively. The residents of the city are primarily located in the built-up area (99%) at a density of about 7000 per km2) (UN, 2000).

Land use function of Addis Ababa indicates good distribution of basic services on its plan (map) but in reality (or on the ground) most of the basic social services (universities, hospitals, big institutions etc) all are concentrated at or around city center. Let us see one simple example of a study carried on Addis Ababa households travelled distance in km to the nearest health center from figure 4.8

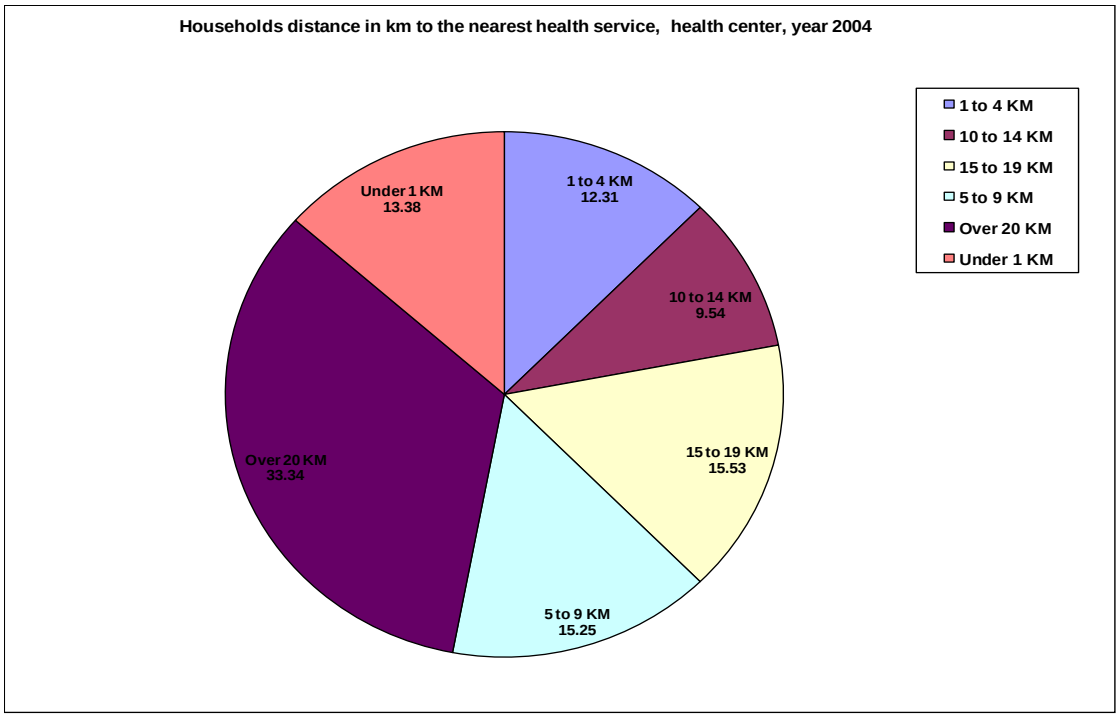



*Figure 4.8 Customers long distance travel to access health center in Addis Ababa*

Fig.4.8 reveals, 33.34% of the customers for that health center travel a distance of over 20km and 15.25% of customers are from a distance of 5 to 9 km. We can recall here the way how the service distribution influence negatively residents' travel (force them to travel to non reasonable long distance) and it will further generate extra transport costs to access that service at far distance.

A transport problem of the city also complicates housing problems and vice-versa. For instance, land and housing market analysis in Addis Ababa indicates that, poor land use regulations and high costs of house prices result on or force residents to live in an areas (at urban peripheries & slums) with no public transport system. A research done on land issues of Addis Ababa indicates that minimum plot (75m2) size is only affordable to 18% of the top income households in city of Addis Ababa. Therefore, land which is classified as residential land use on development plan is only affordable for those small sections of the society. And finally which will result on social exclusion of urban poor from middle and high income groups to live together.

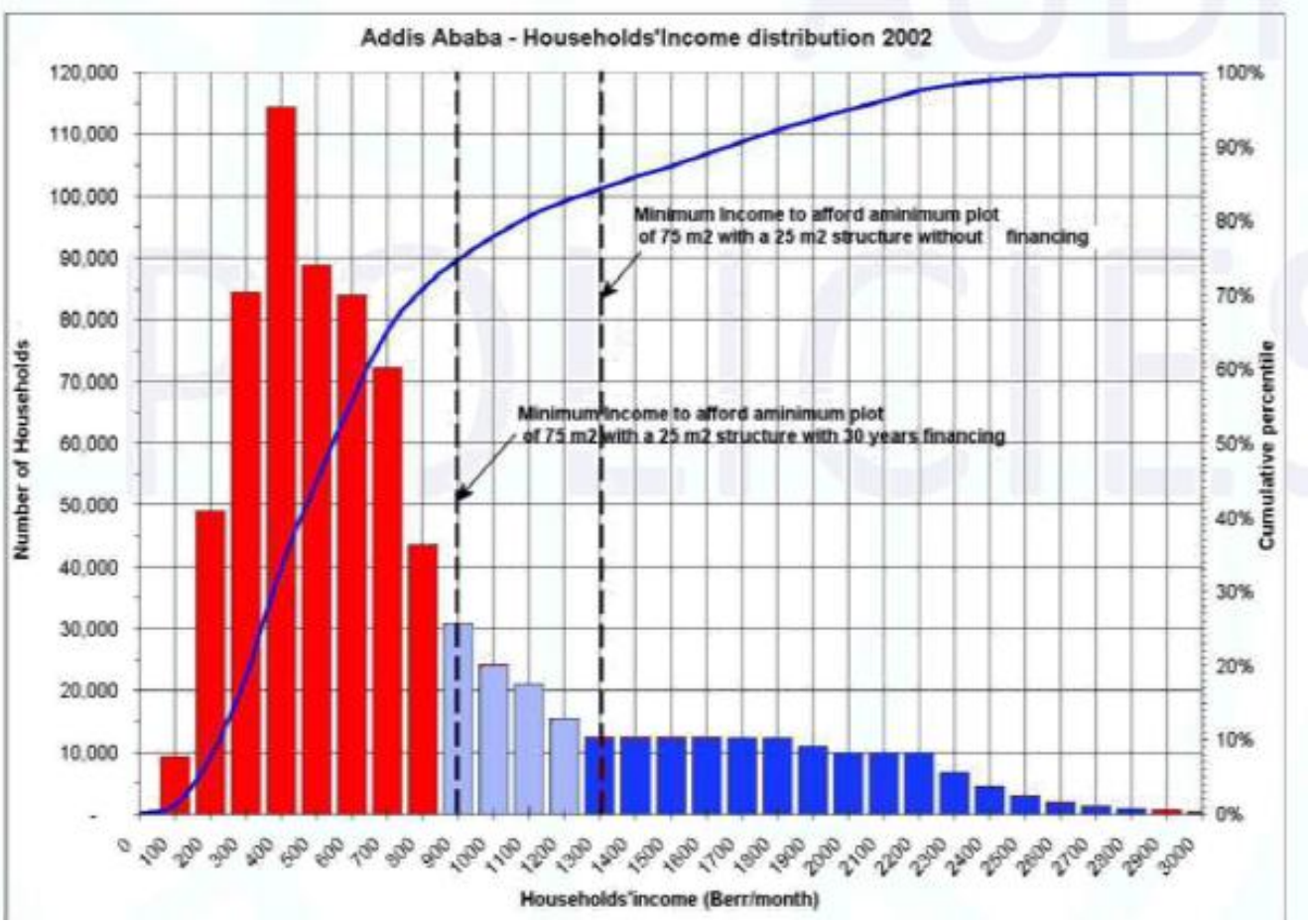



*Fig. 4.9 Addis Ababa households' income distribution in 2002 (Source: UN World Population Prospects 2006 and World Urbanization Prospects 2008)*

The urban poor almost has no means to get own accommodation in Addis Ababa. From fig 4.9, someone to have a plot of land to construct house he or she should have 900ETB (Ethiopian birr) per month income and with 25m2 (built up area) structure with 20 years of financing, which seems very ideal and impractical not only for urban poor but also for middle income groups too.
And thus, cumulative result of the above fact and other related negative bureaucracies of urban land acquisition result on great extent of informal settlements at expansion area of the city. Cumbersome procedures to get land and its high cost could be mention here as a core causes for illegal settlement.

Moreover, recent land value or market price data of Addis Ababa indicates that for inhabitants under the range of low income to medium income groups getting land legally is not an affordable alternative for their housing problem. Although the government is attempting to construct low cost houses called "condominium houses" still it is not affordable for majority of urban poor.
On the other hand, all those already constructed informal settlements are facing sever difficulties to access public transportation, and constraining transport infrastructure development around expansion areas, is also becoming one of the big challenges for the city administration.

The city administration is encouraging self employment of urban youths through small scale enterprises called "tekakene" just providing credits, land and helping them in preparation of business plans. However, youth's who are living at periphery could not participate in various socio-economic activities due to their spatial exclusion. Therefore, unemployment in Addis Ababa still remains much far from the government efforts, that in turn results on another social challenge of less income groups and they couldn't afford public transport fares too. Keeping land use mix and balance of functions and income groups in residential housing development need further study and due attention in Addis Ababa.

☞ *Land use mix on proposed city development plan and on ground reality has a big gap. Thus the city's transport system capacity to bridge this gap and promote mixed land use development is also highly limited. Therefore, for city of Addis Ababa in addition to conventional transport planning practice and efforts, there must be a paradigm shift to accessibility based planning in which traffic flow significantly reduced (except reasonable travel). Although mobility in Addis Ababa is highly constrained and needs insensitive measures on transport facilities development, only promoting mobility will not be absolute solution rather mobility substitutes (such as telecommuting and delivery services) and more accessible land use planning will play great role in minimizing transport costs of inhabitants. Moreover, maintain access to the same range of facilities (as village schools) is very important. The standard of living enjoyed by an individual sometimes will not necessarily be in direct proportion to their mobility. Someone living in a small satellite town with an employment, shops and schools close at hand may well enjoy much greater access to activities than a person in a poorly served housing estate of a large city like Addis Ababa, despite much greater mobility the latter may display.*

❖ ***Roads Convenience for walk and bike***

Roads of the city are classified into four categories on its land use plan, such as: Main or arterial roads, sub arterial roads, feeder roads and local or access roads. Most of Arterial roads of the city has good quality of surfacing, but siginificant length of it has no appropriate walk ways. Local and feeder roads have no quality surfacing, moreover side ditches, street lights, street trees, electric and telecommunication poles and so on complicates their services which constrains walking and cycling.

The Roads Classification and Roads Network

Asphalt & Gravel Roads

| S/n | Roads Hierarchy | Unit of measurement | Length | Length at 7m Width | Number of Bridges | Roads condition |
|---|---|---|---|---|---|---|
| a | Asphalt Roads | | | | | |
| 1 | **Arterial** | **Km** | **344** | **552** | **108** | **V.Good** |
| 2 | **Sub-Arterial** | **Km** | **116** | **167** | **44** | **V.Good** |
| 3 | **Collector** | **Km** | **174** | **209** | **49** | **Good** |
| 4 | **Local** | **Km** | **208** | **208** | **31** | **Fair** |
| | **Total** | **Km** | **842** | **1136** | **232** | |
| b | Grave Road | Km | | 1521 | | |
| | **Total Network** | **km** | | **2657** | | |

*Table.4.4 Road classification and their lengths (Km) (Source: Municipality*

Table 4.4 shows 57% of roads are gravel surfaced, which is inconvenient for walk and bike that play a great role in promoting unsustainable transport modes (relatively using motorized vehicles will be preferable in such road condition). On dry season some part of the city suffer due to blowing wind which carries dusts and other air born wastes. Of course, currently there are intensive efforts on construction of roads at different corners of the city is going on.

Interchange roads

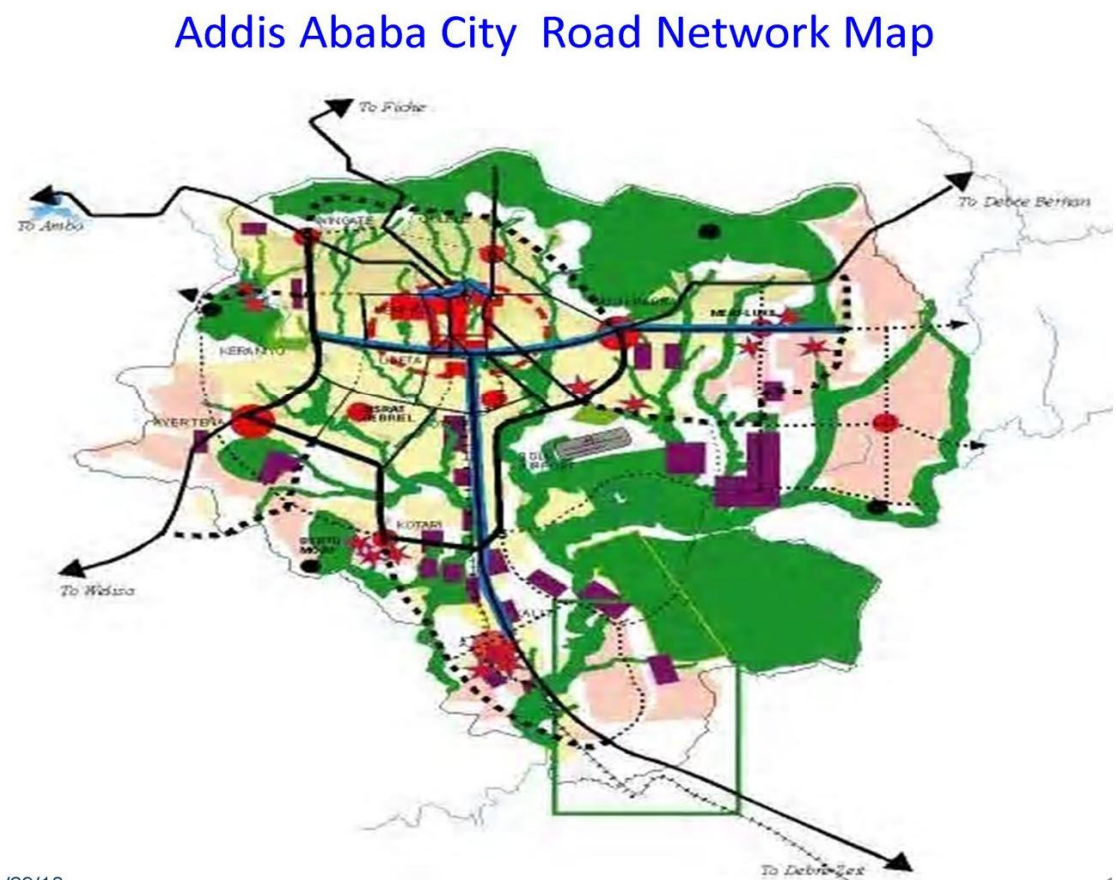
Arterial road types in Addis Ababa

Gravel Access road

*Figure4.10 Different situations of roads and street environment in Addis Ababa*

- ***Overview of quality of roads and street environment in Addis Ababa***

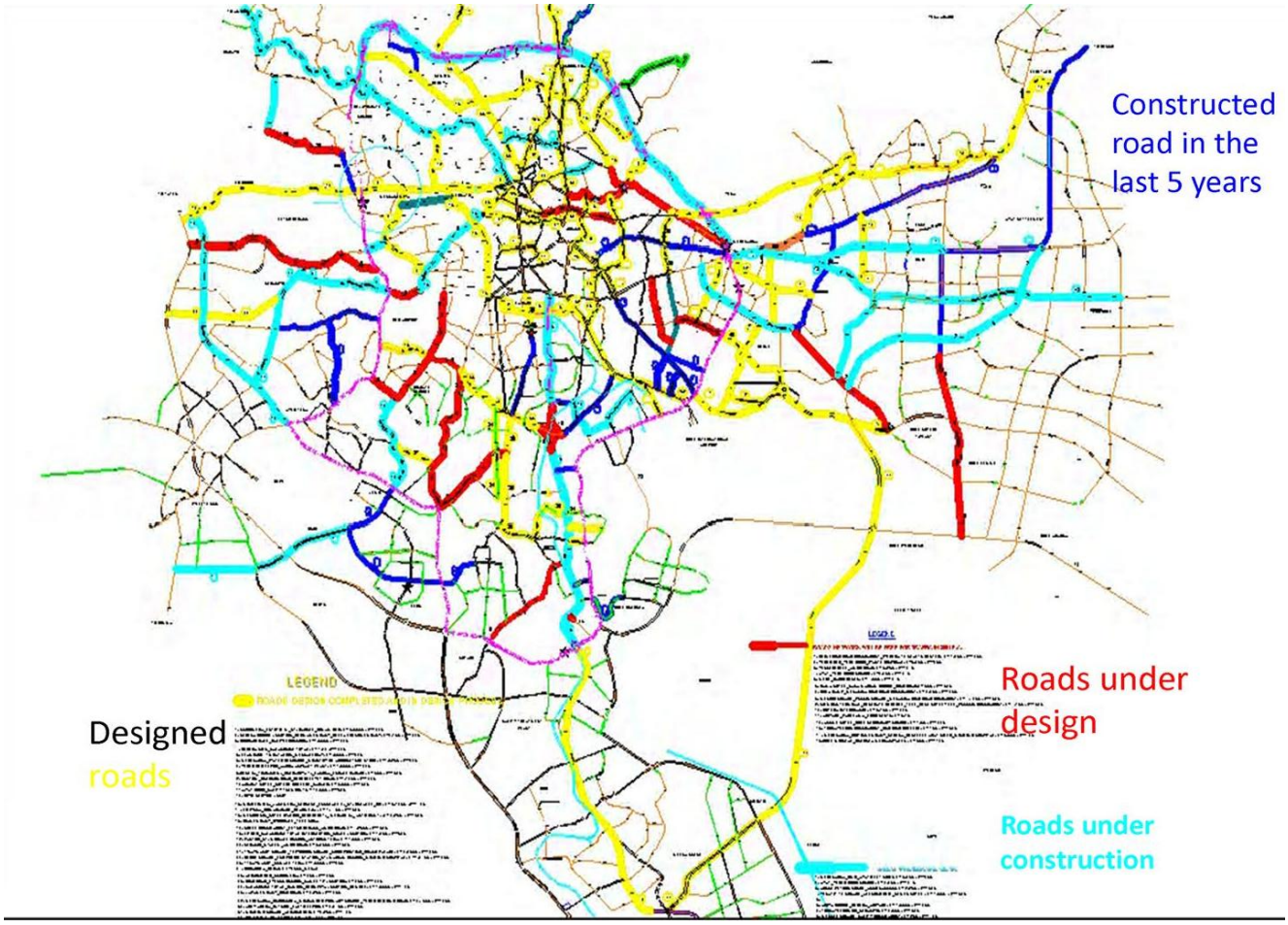
According to Addis Ababa Road Authority, the total length of asphalted road in the city with a varying width was about 328 km before 2003 where as the total length of gravel road with a varying width was about 1100kms just before 2003.




*Map3. 5 Addis Ababa road network map (Source: City development plan of Addis Ababa).*

Addis Ababa municipality (2010) report indicates that, the total road network of Addis Ababa is growing from year to year in a significant decimal, in 2010 it grown up to 3324km. However, the quality of road and street environments still require a lot to be gone and further improvements.

In terms of road density, asphalt road (with a denominator of built up area) was about 1.5% and the total road density (including gravel roads) was about 3.8% in 2003. According to Addis Ababa city administration communication affairs annual published booklet (2010), road density has grown currently up to 12.21 %. However, still the city's main routes are facing sever congestion and other related problems. In urban planning and design standards for a well functioning urban transport system the road density should be within a range of 15% to 20% of the total built up area, and Addis Ababa's reality compared to the international average, it is still very low. For instance, taking the minimum percentage (15%) to satisfy the demand of road for Addis Ababa against the current built up area, it should reach 4086.89km of roads, and thus still 762.89km of (main, sub arterial, feeder and local roads) has to be constructed in near future.




*Map3. 6 Maps of roads constructed, under construction, designed and roads under design within the last 5 years (Source: Office of the Addis Ababa Municipality 2010)*

☞ *The road coverage as well as quality of roads in Addis Ababa on its current state seems far from the notion of transport sustainability, in which strong community cohesion is also expected to be realized through sustainable mobility. Although mobility and accessibility are different concepts, potential mobility is closely linked to accessibility. On the other hand increased mobility may lead to a decrease in social cohesion. However in Addis Ababa transport cases neither mobility nor accessibility is increased.*

## *4.3 Environmental goals*

### 4.3.1 Prevent air pollution

Transport sectors role in causing air pollution could be measured based on per capita emissions of local air pollutants (PM, VOCs, NOx, CO, etc) and by air quality standards and management plans. Although the focus of this study is not to assess in depth technical matters of those mentioned chemical elements (pollutants), emissions due to fuel combustion were briefed.

A pilot-scale air quality study was conducted in Addis Ababa, Ethiopia taking 21samples at 12 different sites between 26 January and 28 February 2004 by (Etyemezia et al 2005). The findings of the study are summarized as follows:

- Light- and heavy-duty diesel vehicles contribute directly to ambient concentrations of PM (non-size specific), carbon monoxide (CO), oxides of nitrogen (NOx), sulfur dioxide (SO2), as well as organic compounds that are toxic, precursors to O3 formation, and can eventually transform from the gas phase to the particle phase.
- Gasoline-powered vehicles result in similar emissions to diesel vehicles, with gasoline engines emitting more CO and diesel vehicles emitting more SO2.
- Airborne lead concentrations were lower than the Ethiopian EPA (2003) standard of 0.5 mgm⁻3 calculated on an annual average basis. This is an especially important finding because Ethiopia had discontinued the use of leaded gasoline at that time.
- Based on analysis of the aerosol components, 35–65% of the aerodynamic diameter <10 mm (PM10) was of geologic origin and which was probably due to paved and unpaved road dust, and 35–60% was due to organic carbon (OM) and elemental carbon (EC). Because Addis Ababa is not highly industrialized city, and thus the sources of carbon that are important on the urban scale are limited to gasoline and diesel vehicles, as well as biomass burning for home heating and cooking.
- CO concentrations measured with portable instruments were within both the 1-h standard (35 ppm) and the 24-h standard (9 ppm).
- Nonvolatile $NO3^-$ represented < 4% of the PM10 mass at most of the sample sites and <7% at all of the sites.

The study carried on air quality in Addis Ababa (Etyemezia et al 2005) also considered both spatial and temporal distributions. At urban sites, EC and OC compounds contributed between 35% and 60% of the measured PM10 while at suburban sites carbon compounds contributed between 24% and 26%. Secondary sulfate aerosols were responsible for <10% of the reconstructed mass in urban areas but as much as 15% in suburban sites, where PM10 mass concentrations were lower. Non-volatile particulate nitrate, a lower limit for atmospheric nitrate, constituted <5% and 7% of PM10 at the urban and suburban sites, respectively.

PM10 concentrations at urban sites ranged between 35 and 97 mgm⁻3. This suggested that if PM10 concentrations measured over the sample period are representative for the year, the Ethiopian EPA annual standard of 50 mgm⁻3 would probably be violated at a number of sites. If most of the carbonaceous material found on PM10 filters is associated with particles from combustion sources, then those particles would be in the fine size range and their relative abundance suggests that the PM2.5 annual standard (15 mgm_3) would also be violated at the same sites.

In summary, with respect to PM10, PM2.5, and lead, ambient air quality conditions compared to Cairo, it was better in Addis Ababa than Cairo, Egypt (Abu-Allaban et al., 2002). Nevertheless, this pilot study suggests that concentrations, especially in urban centers and residential areas within the city, are close to,

but not higher, than the EPA's ambient standards for PM10 and PM2.5. This may be especially true for the annual standards.
One of the Millennium development goals is enhancing environmental sustainability (MDG7). It is also targeted on share of urban residents for whom mobility problems severely constrain access to employment and essential services are planned to decrease it by half.

Globally it is an agreed fact that exhaust gases emitted from vehicle's combustion chamber is not only sources of pollution but also one of the factors for climate change of natural environment. The above study result show that, Addis Ababa transport system is also generating green house gases. Its uncontrolled poor quality vehicles are consuming much diesel and gasoline fuels. There are significant amount of vehicle fleets in Addis Ababa which are out of manufacturers service year standards but still economically serving large number of users either directly or indirectly. Lack of appropriate transport infrastructure is discouraging modern models of vehicles to be introduced. And thus, the majority of the vehicles in the city of Addis Ababa and the country at large remain at least 15 years old and most of them have a smoky trail of pollution (pollutant gases) leaving their tail pipe.

☞ *In Addis Ababa there is no significant mechanism or measures are taking place currently either to alleviate or discourage use of pollution prone vehicles. Per capita emissions of local air pollutants and the exposure to harmful pollutants need in depth study and due attention too.*

### 4.3.2 Prevent noise pollution

Sound in general is essential to our daily lives, but noise (unwanted sound) is not. And therefore, traffic noise level can be used as a performance indicator to assess transport systems sustainability.

In Addis Ababa the average noise /decibel/ level on street has rising from time to time in relationship with increase in number of vehicles and causing various severe problems. The use of large amplifiers by some heavy trucks disturbs the peace not only in residential areas, but also around schools, businesses and health facilities. For instance, study carried on Addis Ababa within five sub-sites for 20-second minimum and maximum outdoor daytime sound pressure levels (SPL) were measured (Berhanu 2009). The World Health Organization (WHO) postulates that the noise levels produced by loudspeakers should not exceed 60 decibels. However, the result of the study in some areas of Addis Ababa shows that sound pollution does exceed the normal standard (60dB) given by WHO (1999) by a small amount but it should be given much consideration so that it won't exceed this in the future.

Various medical researchers have proven that, noise in general can cause change in blood pressure that can induce heart attacks and strokes. Moreover, in case of human health impact the World Health Organization (WHO 1999) confirms that chronic exposure to noise, including daytime traffic, is strongly associated with disease and premature death. It can affect both health and behavior in nature too.

According to WHO noise level inside car which is in average 85dB from city traffic, 90-95dB noise levels at which sustained exposure may result in hearing loss, 140dB even for short term exposure can cause permanent damage and it is loudest recommended exposure with hearing protection. Traffic noise is serious problem all over the world, for instance according to the studies conducted in Europe, traffic noise is the second biggest environmental problem affecting human health in Europe, after air pollution. Traffic noise level higher than 60dB cause 1.8% of heart attacks in the populations studied, road traffic causes almost 80% of the noise annoyances in Norway. Moreover, traffic noise alone is harming the health of almost every third person in the WHO European Region. One in five Europeans is regularly exposed to sound levels at night that could significantly damage health.

☞ *Noise pollution have a number of health problems and beside that it impairs performances, increasing errors, and decreasing motivation, reading attention, problem solving, and memory are notably affected by exposure noise, particularly in the case of children. In Ethiopia there are laws and regulations like Environmental Pollution Control Proclamation and Environmental*

*Impact Assessment proclamation, which address noise pollution at federal level. Article 5 of The Ethiopian Environmental Pollution Control Proclamation No.300/2002 that came into force in late 2002 specifically lists noise as a harmful, prohibited pollutant. In addition, Addis Ababa Administration has also issued a directive in 1995 on hygiene and health care protection that integrated noise pollution. In summary, the problems are mainly due to lack of responsible government offices to enforce the regulations and Addis Ababa noise pollution does deserve further attention of the stakeholders.*

# *5 MAJOR FINDINGS AND CONCLUSION*

Here as follow main findings of the result of the study are offered for further attention or consideration. Later on summary of the study will be posed answering the research questions as conclusion and indicating plausible solutions for the problems.

## 5.1 Findings

- Disorganized and unsustainable public transport service:

Public transport services in Addis Ababa are basically dependent on city buses, midi-buses, minibuses and taxi services. All are working for the same goal that is to satisfy transport demand of the city of Addis Ababa. However none of them have significant service coordination. For example, there are an areas with sever public transport problems that lack any means of motorized transport and at the same time there are another areas with service competition among each other. Road network is one of the reasons for 'Anbessa' service to be constrained lacking to cover major routes due to limited transport infrastructure, lack of coordinated management of buses and minibuses are also another crucial problem. Midi-buses, minibuses, and taxis have no specified routes to work; rather they could work wherever their drivers feel profitable. In some areas (like 'Megenagna' terminal) both bus and minibuses have loading and unloading terminals at the same location, which in result on congestion, noise, prevalence of traffic accident, and confusing travelers to get intended routes. However, during data collection of this study, transport authority declared taxi zoning which enforce minibuses to work only in specified routes.

Moreover, Addis Ababa city bus transport service is not comfortable means of public transport, especially not preferable by middle and high income groups due to its long waiting time, lack of consistent schedule, over crowdedness, lack to satisfy spatial equity (especially urban periphery and slum areas are poorly served). Furthermore, it is highly dependent on government subsidy for its operation since its revenue much less than from expenditure, and less number of its vehicle fleets also limits its services. Regardless of limited vehicle fleet and weak capacity of city buses: urban expansion, population growth, current weak economic condition of majority of the resident's forcing the modal shift to 'Anbassa' which is causing its problems worst than ever.

Minibuses and Old Russian car lada are not affordable types of transport mode for majority of urban poor in Addis Ababa. Lada costs 80-100 Birr within city center on day time for one travel and this price will be changed to higher price at night time. Minibus costs for shortest (0-2km) distance: 1.10 ETB, Next stage to short distance: 2.25 ETB, the one after that: 3.00 ETB, and the next: 3.20 ETB which is totally not affordable for urban poor. Moreover its less security and unkind treatment of customers are also among the common problems of this type of transport. Traffic accident by minibuses is frequent phenomenon in Addis Ababa, and thus relatively it is less secure type of transport mode. They have no well organized fixed stops and minibus taxis do not operate to scheduled timetables but follow the practice of full-load dispatching which usually result on annoying delay. Furthermore, taking into account the amount of fuel energy consumed, level of traffic chaos, noise pollution, and low degree of efficiency as far as number of people transported per trip, the minibuses, 'weyeyet' (Russian lada) and midi-buses are not sustainable modes of public transportation for Addis Ababa. In general public transport system of Addis Ababa does not allow sustainable mobility which let travelers to arrive their destination in reasonable travel time and cost.

- Lack of different transport mode choice and prevalence of environmentally unfriendly transport practice

Addis Ababa has no comfortable environment in terms of transport mode choices. The city's poorly developed transport infrastructures discourage environmentally friendly modes of transport. Cycling in Addis Ababa is not used as a means of transportation, of course the city's most parts are naturally not convenient for bike ride, but even areas with comfortable topography have no yet isolated bike ways. Pedestrians take significant share of transport modes (30%) regardless of inappropriate road conditions. Lack of mass transportation means such as: BRT (Bus-rapid transit), trolleys, tramps devastating public transport load on existing system and which in turn causing severe problems on overall productivity of the city. Private sector participation on mass transportation is significantly weak due to its high initial investment cost and not welcoming environment of current transport policies. And thus, the results of this study show us transport accessibility and mobility of Addis Ababa is highly constrained by all those above mentioned problems. Moreover, according to the notions of sustainable transport system, that could be measured by set of indicators which reflects various objectives and impacts. Addis Ababa's weak transport services contribute negatively for city's economic productivity, access to employments and education opportunities, community development and etc

- Inadequate road transport infrastructures

One of the main reasons for Addis Ababa's transport system to malfunction is its incapable status of road transport infrastructure. City buses with greater carrying capacities that carry four times of midi-buses and eight times of minibuses, regardless of this fact it has no isolated or separated lanes and run along with minibuses and taxis on congested routes even at peak hours. Technical quality of the roads in some parts of the city has serious problem, for instance different studies show that 1% of the total traffic accidents' occur in Addis Ababa due to lack of appropriated road design.

Roads in terms of coverage, density as well as quality still need further improvement. Most roads have no appropriate sidewalks (e.g. incase if a road has walkway, probably it is unpaved or inappropriate), no clear traffic signs, lack of street chairs and shades especially at bus stops, open side ditches even at high pedestrian routes which sometimes cause accidents specifically for handicapped, children and aged people. In Addis Ababa road development efforts not only lacks to achieve its minimum criteria (i.e.at least 15% of land uses should be covered by road) urban area's land devoted to transport facilities, but also not at a status to fully enhance land mix notions.

- Lack of effective traffic management

Ethiopia is a country with highest traffic accident in the world in contrast to its less number of vehicles. In Addis Ababa more than three hundred (300) people die of car accidents and injure thousands every year. The damage to property caused by these accidents which claimed over 3065 lives-leaving injuries aside-over the last ten years amounts to more than 8.4 million euro. Private cars are more susceptible to traffic accident in Addis Ababa, and relatively city buses share low accident record.

Traffic flow in most area is controlled manually by traffic police officers and signal control lacks in some important junctions. Traffic jam is common phenomenon in city centers at peak hours which result in high travel costs (costs time and money). Moreover, road safety requires institutional cooperation and coordination among road development agencies, transport agencies, traffic police agencies, and public mass media; however in realities this lacks in Addis Ababa.

Furthermore, lack of clear rules on speed control and vehicle service years contributing a lot for current severe traffic accident records. And thus, mobility without safety will not be considered as sustainable transport.

## *5.2. Conclusion*

In this section conclusion of overall study was done in a way that it briefly to answer the research questions which are posed in chapter one. And finally, before recommending solutions for the problems general summary of the overall research and critical issues has been highlighted linking the ideas of all chapters as a whole.

**Question1**: What is sustainable transport systems' accessibility/mobility?
It is very common to see the word 'sustainability' in a number of books, journals and papers. And arguments on concepts of 'sustainability' in different topics, there is a growing interest in concepts of sustainability in various fields of study in the last decade or so. In transport sectors, sustainable transport system were defined and re-defined in different and/or similar ways by various concerning bodies. However, some of them are appropriate and commonly used, others are still ambiguous, and a few are illogical or narrow viewed. Transport sustainability measuring mechanisms or its performance indicators are also varying from one scholars to the other, and one organization to the other too (see for detail section 2.4.7).
An attempt to categorize different interpretations of sustainable transport system and the complexity of the debate on it also yet not get single holistic definition that satisfies all. And thus the question, what is sustainable transport /system/? It has no exactly this or that kind of answers, since there are different sources of interpretations that are under framed in the objectives of interpreter. Moreover, as far as if someone is only concerned on a single definition or interpretation, he/she might have a probability to be under boundary of narrow view. Thus, among others due to its comprehensiveness and wide view definition of CST (see sub-section 2.4.) becoming more familiar recently in transport sector. Therefore, throughout this study (paper) sustainable transport system mean it is "CST's" definition. CST defined sustainable transport system as:

- *Allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between successive generations.*
- *Is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.*
- *Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise*

It is one of the best recently evolved definition for sustainable transportation which accounts on its definition the welfare of economy, environment, and society or it considered all 'triple bottom line' of sustainable development too.
And another important concept which dealt in this study was "sustainable transport systems' mobility" or "sustainable mobility". In 21$^{st}$ century especially within urban areas, most activities are highly dependent on mobility. Moreover, present life style which is dominantly dependent on travel is not only beneficiary of output of increased mobility but also affected by extra costs of congestion, pollution, traffic accident, and general travel costs. Therefore, realizing sustainable mobility is also another notion which requires urgent measures. The World Business Council for Sustainable Development defines sustainable mobility as:

- *'the ability to meet society's need to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values, today or in the future' (WRI, 2004).And therefore, we can see from this definition that sustainable mobility is kind of subset of sustainable transport system and potential mobility is closely linked to accessibility. Accessibility is the amount and the diversity of 'spatial opportunities' that can be*

*reached within a certain amount of time. The core point of accessibility-mobility is that,* a mobility *improvement is a reaction in the generalized (i.e. time-plus-money) cost of travel per kilometer*; *and an accessibility improvement is a reduction* in the *generalized cost per destination*" (Levine &Garb, 2002). *In other words, accessibility focuses on the ways how to reduce movement to get services, goods and people from where they are needed.*

**Question 2:** What are the main factors which could affect sustainable transport systems' accessibility/ mobility in Addis Ababa?

Addis Ababa's transport system is currently under several problems and still more susceptiable to be easily affected by factors such as: fast and unbalaced population growth versus transport infrastructures progress, urban expansion, inadequate transport infrastructures, lack of good governace and transport rules and regulation gaps, natural topography,

Addis Ababa is one of sub-saharan cities, which showing fast population growth in a situation of weak capacity of infrastructure to handle demands of its residents. By 2015, the Sub Sahara African region is expected to have five cities larger than 5 million inhabitants: Abidjan, Addis Ababa, Lagos, Luanda and Kinshasa (Gwilliam, 2003). And therefore planning to change current disorganized and unsustainable transport situation taking in to account the issues of fast population growth is an urgent task. Especially for the cities like Addis Ababa where residents' mobility is highly dependent on public transport system for their day to day activities population growth is one of the main factors which could affect transport sustainability. The study carried on 150 cities in developing countries show that, for every additional 1,000 people in developing world cities, an extra 350-400 public transport trips per day will be generated. Similarly, for every additional square km of city growth, an extra 500 public transport trips per day will be generated (SSATP 2002).

Although accessibility based planning (see sub-section 2.4.5) becoming recent transport planning fashion, in a such cities like Addis Ababa, where transport infrastructure is at its very infant level which needs due attention for its further development. Therefore, it is unthinkable about sustainable transport systems' accessibility/mobility unless and other wise basic infrastructure is sufficiently realized. Transport infrastructures are among main factors which could affect transport systems efforts toward sustainability in Addis Ababa. Land use mix is also has great influence to on transport system of any city. A smart land use development can contribute a lot both in terms of accessibility and keeping smooth mobility. An area with improperly developed social services, markets, various administrative centers and employment opportunities could definitely affect transport system functioning of city at large and specifically at those areas. Therefore, as far as land use of a city which consists or have fairly distributed services will positively contribute to well being of city's overall transport system. In this regard in Addis Ababa a lot has to be done, most things remain on its plan (map or blue print) and a plan which could not be implemented might not have more significance than nothing.

Addis Ababa has different rules and regulations related with urban transport service, however the magnitude of chaos and crisis resulted from malfunctioning of transport system is too much. For instance there is a rule concerning environmental pollution of urban traffic. However, the level of noise pollution and air pollution seems no one is responsible. In public transport service the city transport authority usually authorize buses and taxis fares based on fuel's market price; however minibus drivers can change artificially breaking the length of the routes. In general, rules and regulation could either affect positively or negatively sustainable transport systems of Addis Ababa. And therefore, in this regard what is happening illegally in city is due to its weak implementation strategy and feedback evaluation problem.

Addis Ababa is known by its terrain and thus, most part of it is not convenient for cycling which environmentally friendly transport mode. And therefore, it has to some extent will have negative influence on transport sustainability paradigm shift towards non-motorized modes encouragement. Finally, lack of

strong public private partnerships could affect significantly transport systems subsystems sustainability in Addis Ababa. For instance, if the government maintain subsiding city buses "Anbasa buses" private sectors will be discourage to participate in this field and therefore it needs serious attention to cooperate both governmental efforts with private sector investment.

**Question 3** What is the situation in Addis Ababa in relationship with sustainable transport systems' accessibility/mobility?

Addis Ababa current situation in relation with sustainable transport systems' mobility/accessibility analysed in chapter 4 in detail. Here only to give an overview or highlight of some concluding remarks based on the three sustainability pillars (economic, social, and environmental aspects).

Performance indicators are used to evaluate the status and role of Addis Ababa transport system to enhance various (economic, social and environmental) goals. For instance, its role to achieve economic productivity is assessed based on the level of congestion and or per capita congestion delay. Congestion is hampered significantly Addis Ababa's economic activities. Urban poor has no various alternative mode of transport and usually relay on city bus which has almost equal share of congestion with other motorised modes of transport since there is no separate bus lines (lanes). Especially at peak hours (such as in early morning 7:00 am- to – 9:00 am and 4:00 am to 6:00pm) public transport users have no option to move in reasonable travel time and their work time, productivity, could be affected significantly and which in turn result on poor economic development.

In Addis Ababa there are many small taxi and minibuses which consumes much imported fuel and increase per capita transport energy consumption. And therefore, the city's current transport system capacity to reduce much energy consumption is very weak and constrained to achieve energy efficiency goal. Moreover, the city has significant number of out to date vehicle fleet which on the other hand encourage extravagant fuel use.

All residents can not afford equally basic (essential) services and activities due lack of quality transport system. There are only limited modes of transports. City bus has extreme number of customers regardless of its poor quality services and less capacity. Minibuses and Taxis are not affordable modes of public transport in Addis Ababa for urban poor and in some cases even for middle income groups too. Quality of transport infrastructures is very poor to accommodate cycling and encourage safe walking, which both are environmentally friendly modes of transport.

Moreover, Addis Ababa transport system has no capacity to accommodate various users, including those with disabilities, low income, and other constraints. There are an areas where no means of motorized transport modes (e.g. some expansion areas, slums and squatter settlements). In general, Addis Ababa transport system lacks vertical equity that considers incompetent groups of people and costs and benefit is fairly distributed between groups in society. Moreover, spatial equity (distribution of activities in space), social equity (considers age, sex, educational level, household structure, disability or handicap), and economic equity (poor and non-poor). In Addis Ababa mobility is highly constrained for marginalized groups of people and there is almost null public transport alternative access for those groups. Thus it is a kind of the fittest can survive and which exclude significant number of the society from various social activities and require urgent measures.

Safety, security and health matters with respect to transportations issues do not get equal responsible attention by all concerned stakeholders. Of course the traffic accidents and severity of the magnitude of the problem is not only framed under city of Addis Ababa, rather whole country has significant problem in this regard.Ethiopia in general has worst record of car accident fatalities of 155/10,000 motor vehicles

compared to 60/10,000 motor vehicles in Kenya and 17/10,000 motor vehicles in South Africa, ranking among the highest in Africa.

According to Addis Ababa Transport police Office (2011) report, more than three hundred people die of car accidents in the capital and injure thousands every year. And again, the study conducted on the cost of road accidents in the capital and elsewhere in the country revealed that road accidents in the capital account for 65% total accidents occurred in the country. As regards to the proportion of the victims, 82.6% occurred on pedestrians with the remaining 14.51 and 3.42% accident shared by the passengers and drivers respectively. The damage to property caused by these accidents which claimed over 3065 lives-leaving injuries aside- over the last ten years- amounts to more than 200 million Birr (ETB is local currency, 1Euro= 24 ETB). Addis Ababa has small number of vehicles but highest traffic accident, which is ridiculous and an indication of weak traffic management practice.

Both fatalities and serious injuries record indicates that the city is at its risk level and require urgent traffic management process re-engineering and needs advanced techniques in order to minimize traffic accidents. And moreover, various alternative scenarios have to be developed which may brought measurable and actionable recommendations that help and could influence decision maker's view in strategic planning and on their political decisions too.

An inappropriate transport infrastructure aggravates various social problems of the society. Community cohesion is either directly or indirectly affected due to unsustainable mobility characteristics. Recently city administration of Addis Ababa, developing road infrastructures intensively, however social issues and poverty is still far of getting better.

The role of Addis Ababa transport system to enhance environmental goals such as preventing air and noise pollution are assessed in this study. Noise pollution has become a matter of great concern for Addis Ababa in recent years. Residents of the city face wide-ranging adverse health, social, and economic effects caused by noise pollution emanating from socio-economic activities in many sectors such as religion practices, open air festivities, as well as the construction, industrial, transport, commercial and domestic sectors, etc. In 1999 WHO recognized seven categories of adverse health effects of noise: hearing impairment, interference with spoken communication, sleep disturbances, cardiovascular disturbances, disturbances in mental health, impaired task performance, and negative social behavior and exasperation reactions. Vulnerable groups include patients in hospitals, infants and young children the of disabled and the elderly are also becoming casualties of noise pollution.

According to WHO noise level inside car which is in average 85dB from city traffic, 90-95dB noise levels at which sustained exposure may result in hearing loss, 140dB even for short term exposure can cause permanent damage and it is loudest recommended exposure with hearing protection. Indeed, the World Health Organization (WHO) postulates that the noise levels produced by loudspeakers should not exceed 60 decibels. However, the study result in some areas of Addis Ababa shows that sound pollution does exceed the normal standard (60dB) given by WHO (1999) by a small amount but it should be given much consideration so that it won't exceed this in the future.

The pilot study carried on air quality of Addis Ababa in 2005, suggests that concentrations especially in urban centers and residential areas within the city, are close to, but not higher than the EPA's ambient standards for PM10 and PM2.5. At urban sites, elemental carbon (EC) and organic carbon (OC) compounds contributed between 35% and 60% of the measured PM10 while at suburban sites carbon compounds contributed between 24% and 26%. Secondary sulfate aerosols were responsible for <10% of

the reconstructed mass in urban areas but as much as 15% in suburban sites, where PM10 mass concentrations were lower. Non-volatile particulate nitrate, a lower limit for atmospheric nitrate, constituted <5% and 7% of PM10 at the urban and suburban sites, respectively.

PM10 concentrations at urban sites ranged between 35 and 97 mgm_3. This suggested that if PM10 concentrations measured over the sample period are representative for the year, the Ethiopian EPA annual standard of 50 mgm_3 would probably be violated at a number of sites. If most of the carbonaceous material found on PM10 filters is associated with particles from combustion sources, then those particles would be in the fine size range and their relative abundance suggests that the PM2.5 annual standard (15 mgm_3) would also be violated at the same sites.

- *Addis Ababa is far better than it was a decade ago. But the new construction projects and the glare of shiny high-rise buildings should not hide the urban poor who live in deteriorated slum settlements without any transport route and services. Many at periphery are still living in harsh conditions. Moreover the urban poor are directly threatened by inner city redevelopment projects. Low-income households mainly living in slums bear the pains of displacement and livelihood disruptions. Relocations are mostly done to the outskirt of the city where there is limited or no access to services and transport infrastructures.*

  *In developing countries' cities like Addis Ababa car ownership has not gone up corresponding to the population growth rate, thus public transport operations have a dominant role in urban mobility. less car ownership situation of Addis Ababa only could be considered as an advantage in terms of sustainability, if and only if, public transport and other modes of alternatives being facilitated, if not it might not be better than the from the situation of high number of motorized vehicles. And therefore, existing public transport system especially city bus /Anbessa/ can serve as a stepping stone or as an umbrella to realize and crate basis for public private partnerships. An integrated public transport network development and transport management needs new and advanced mass transportation systems which could carry highest number of people at the lowest cost of the society.*

  *Therefore, the situational analysis and evaluation result indicate that Addis Ababa's current transport system is neither sustainable nor exactly towards the direction of transport sustainability in most aspects. Moreover, it is safe to say that, the current situation is far more to reach sustainability according to evaluation result of performance indicators. Furthermore, there is no single absolute way (or mechanism) to achieve sustainable transport system in Addis Ababa due to its complex current situations and comprehensiveness of sustainability notion itself. However, most agree that in general balancing economic, social and environmental goals in an effort of sustainable transport system development is crucial and best option. Effective transport system has great impact on overall urban development, and on the other hand, its sustainability could be influenced by other sectors too. The envisaged strategic responses or specific recommendations of this study are briefed in the next chapter.*

# *6 Recommendations*

The magnitude of the transport problems in Addis Ababa is much more complicated, and in such status quo finding solution for the problems also seems not easy task. However, this study pinpoints core issues that needs due attention and forwards some basic recommendations as a solution:

- Accessibility focused transport planning

This type of transportation planning is becoming widely acceptable in current transport sustainability notions (debate) that focus on spatial opportunities rather than mobility. The intention of this type of planning approach is to let people not need to have a car at a suitable scale (within walking or cycling distance). Enhancing land use mix and smart growth concepts can play great role in accessibility planning. In Addis Ababa, majority of urban and other similar marginalized groups are not equally participating in different economic activities and social issues due to transport related problems to access dispersedly distributed services and various employment opportunities.

And therefore, by distributing fairly basic services at different corners of the city, it is possible to create active sub-centers which could accommodate various demands locally and which in turn avoid long distance travel. Volume of people travelling from one specific area for searching a service or goods will significantly decrease, which in turn will reduce total sum of congestion, level of energy consumption will decrease, it can contribute positively declining traffic accident and time spent in travelling will minimized too, by doing so, accessibility notion will play great role in achieving transport sustainability. Increase mobility for non drivers in reasonable distance not only helps to minimize monetary costs, rather environmental and social costs could be reduced significantly, and thus accessibility can be considered as sustainable mobility.

- Encouraging environmentally friendly transport modes

Implementing improved non-motorized transport infrastructure (sidewalks, bikeways) and applying travel demand management in Addis Ababa's situation is very important option. It is relatively simple, low cost and effective solutions for Addis Ababa transport problems. It contributes a lot to achieve environmental goals such as reductions in air pollution and noise from road vehicles etc. In medium and long terms planning to reduce growth in private motorized vehicles is also basic thing that should be considered, beside encouraging environmentally friendly modes that reduce traffic congestion and greenhouse gas (GHG) emissions.

- promoting public private partnership

Institutional cooperation and coordination is very important to achieve sustainable transport systems' mobility/ accessibility in Addis Ababa. Transport sector stakeholders should be aware of the fact that mutual benefit will be maximized when they come together and share both costs and benefits equally. Public owned city bus is not effective enough to sustain Addis Ababa's transport system. Private sectors investments are very important in public transport, and the government has to create conducive working environment. If public private partnership realized in Addis Ababa the service quality of transport system will be improved and contribute to competitive market in which society will be beneficiary. The gap which is not filled by government will be filled by private sector and vice-versa. Moreover, disorganized public transport services could be avoided through cooperation. To reach this goal, building awareness and understanding among policy makers, key stakeholders and the general public is needed. For instance,

decision on public transportations route selection, planning, designing, construction and feedback evaluation should involve key stakeholders both from public and private sectors.

- developing an alternative mass transportations

The existing public transport system in Addis Ababa is inadequate to provide services for the existing travel demand. The overall performance of 'Anbessa' is hampered due to many problems, of which the low vehicle fleets and poor technical fitness of most of the vehicles are critical issues. Concerning transport infrastructure development, there is no doubt regarding the need to expand and improve it in Addis Ababa. However, improvements in infrastructure in Addis Ababa, alone do not guarantee an improvement in the transport sustainability situation of this city. The city does not have quality transport infrastructures which allow or create an environment at which all users equally to benefit from services and economic activities.

In Addis Ababa, during data collection period of this study future plans of transport system development was also referred, and additional discussions were undertaken with domain experts on an issue indicates that there is an attempt for planning of light rail transit, bus rapid transit (BRT), non-motorized transport, and transport demand management measures already in progress. The plans sounds good with regard to findings of this research, but it needs great capacity and commitment of key stakeholders to implement.

For sustainable transport system development, car ownership and public transport accessibility is equally important in Addis Ababa at its current status. However due its poor economic condition of majority of the society, in Addis Ababa mass transportation is relatively more important and urgent among other modes of transport. In general, realizing an integrated public transport network in Addis Ababa and transport demand management measures is difficult to realize but essential.

### *Further research area*

This study has carried on city of Addis Ababa, where no research done on similar topic 'sustainable transport systems' before, that might lead to some minor shortcomings on an outputs. And therefore further research is needed to determine how recommendations of this study can be implemented successfully and what should be short, medium and long term strategies that could avoid or minimize the risks? It is known that is planning to achieve certain goals is challenging, and moreover, implementing a plan is again more challenging.

Thus, which type of recommended solutions should get priority for its smooth implementation process or how it is possible to realize all in combination with limited financial and skilled human power of Addis Ababa? And what will be result or influence of one on the other if in case an intensive but imbalanced implementation effort or attention given could it be smooth implementation process? For instance, if great focuses given to mass transportation means and if insignificant measures taken on environmentally friendly modes, later on could it be easy to encourage cycling? . Finally, making the link between transportation, basic human needs (both social and economic), and environmental goals need further research how to achieve in implementation phase as well as after the development for future generation too.

Four research questions of this study have been answered based on theoretical knowledge (i.e. discussed in chapter two in detail), referring various trends of statistical data, practical situation analysis, discussions made with transport experts of Addis Ababa transport authority, analysis and evaluations. But still, it might have some minor drawbacks due to various unforeseen circumstances' that so far could be improved by further research.

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