Integrating Public Transport Networks and Built Environment:
The case of Addis Ababa and experiences from Stockholm

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Abstract

Cities are places of opportunities and growing urban challenges where the prioritization of appropriate transport technologies and infrastructure is crucial to respond to the growing challenges of rapid urbanization, high level of congestion, urban sprawl, climate change and energy issues. Transport technology plays a major role in defining urban form and determining the spatial arrangement of activities and hence the extent to which important destinations are accessible. The city of Addis Ababa is striving to address the pressing transport problems and growing urban challenges through the implementation of transport master plans and high profile road projects. In light of this, the contemporary urban development and transport planning practices are researched from the perspective of providing sustainable accessibility, complete street design, placemaking, compatibility to public transport network and competency of new road infrastructure to current and future challenges of the city.

The research explores the case of Bole road of Addis Ababa and LRT-based neighborhood of Stockholm to examine the relation between public transport and built environment. The findings show that both study areas are important urban corridors that offer broad range of destinations/services and have good connectivity to city center and to the proposed/existing public transport network. However, the 40m wide new Bole road is designed in a conventional transport planning practice aimed at reducing congestion and this limits its accessibility, placemaking and prospect of complementing the LRT and BRT networks. On the other hand, the 37.5m wide transit corridor of Stockholm provides high ridership, better accessibility and placemaking through the design of compact and mixed use developments and pedestrian friendly street design. The study also show that despite Addis Ababa being a walking city, more than 65% the road network is not pedestrianized and the provision of dedicated bus lanes, adequate pedestrian facilities and/or cycle paths is given less priority in the design of new urban transport infrastructures.

The research concludes by highlighting transit-oriented development (TOD) and complete street design as effective planning instruments for enhancing accessibility of neighborhoods, urban centers and metropolitan city regions through the building of transit-based, pedestrian-friendly, compact and mixed-use urban environments. The coupling of transportation interfaces and land use activities and hence sustainable urban development can be realized through the principles of complete street design and TOD which enable cities to create places of high accessibility and vibrant street life. These practices are also important for preserving the most sustainable transport modes, for greening urban corridors and enhancing the functionality and livability of cities. A practice of urban planning around transit corridors and building of competent road infrastructure is recommended so that Addis Ababa can live up to its name by providing decent quality of transport service/alternatives to its citizens and improving the environmental quality of the city.

Keywords: Public transport networks, Accessibility, Complete street, TOD, Placemaking, built environment, Addis Ababa, Stockholm
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1 Introduction

Cities are at different wavelengths in terms of their context and historical development. It is however, their respective choice of either automobile oriented transport system or public transport (transit) that leads to sprawling or compact city which in many ways dictate the progressive developments afterwards. Transport technologies have shaped the pattern of urban development and form of cities throughout history (Rodrigue, 2009; Cervero, 1998; Newman and Kenworthy, 1999; Stojanovski et al, 2012) giving them a monocentric and/or polycentric urban configurations in the process.

Transport is the engine of social and economic activities. The provision of competent and efficient transportation system is of paramount importance for the cities especially in the modern era of globalization and information age where cities are the centers of urbanization and propellers of national and global economies. Addis Ababa, the capital city of Ethiopia, is the heart of social, political and economic activities of the country and is the 4th largest diplomatic center in the world as the city is a seat of UN Economic Commission for Africa (UNECA) and African Union (AU). Addis Ababa is experiencing a fast paced urbanization which imposes intense pressure on the urban infrastructures, particularly on transport. Urbanization is a challenge which when coupled with congestion and automobile oriented-development practices intensifies the magnitude and dimension of urban problems across cities of the world, particularly in developing cities like Addis Abba. Addis is already in peak pressure of providing competent transportation infrastructure and service that can absorb the pressing demand of the ever growing population. In light of this, the city is striving to overcome the current transport problems and the inevitable future challenges through the introduction of LRT and BRT lines and development of high-profile road projects like Bole road. The city is at a crossroad.

1.1 Problem formulation

1.1.1 Cities, Transport and Urban form

All cities have been shaped by transportation technology priorities coupled by economic and cultural priorities of how to use urban space to a greater extent (Rodrigue, 2009; Newman and Kenworthy, 1999). Urban sprawl is the legacy of three types of public transport technologies that shaped cities in to elongated and interwoven city of buses and trans, the railway city of pearls and networked city of subways/metros whose hybrid gave rise to the compact city of light rail transit (LRT) and busways/bus rapid transit (BRT) in the 20th century (Stojanovski et al, 2012).
automobile-oriented development pattern by which most cities of America like Los Angeles are characterized. Today automobile dependency becomes the apparent reality in the cities of both the developing and developed world and predominantly in American cities. Following WWII, automobile dependency has accelerated and progressively become the transportation pattern that shaped many of the American cities (Newman and Kenworthy, 1999). Unlike American cities, European cities on the other hand have managed to retain their transit-oriented form and tram systems, though car dependency still prevails at the outer fringes of their cities in recent decades. Transit corridors of Stockholm are the building blocks of city structure that paved the platform for the present form of the city. In Stockholm, transits account for 55% of the trip to work due to exceptional integration of the mixed-use sub centers around rail transit stations (Cervero, 1998; Newman and Kenworthy, 1999). The choice of transportation pattern defines the form of a city and set the framework for future development.

A rise in income level and the obsession for car will underestimates the need for public transport and transit oriented development and as a result investments may shift towards automobile oriented transport infrastructure. The UN-HABITAT 2010/11 report on State of the World Cities states that:

“Urban sprawl in developing countries takes two forms: ‘peripherization’ (peri-urban informal settlements by the urban poor and ‘suburban sprawl’ (residential zones for high and middle income groups)... Rich and poor seek refuge outside the city, which generates further partitioning of the physical and social space.” “In a nutshell: sprawl is a symptom of a divided city” (UN-HABITAT, 2010/11).

In many developing countries, suburban sprawl is triggered by the authorities’ lack of attention to public transport (PT) and other urban services (UN-HABITAT, 2010/11). And this is inevitably accompanied by the automobile-oriented real estate development practices at the outskirts. Newman and Kenworthy (1999) argues that changing transportation priorities from auto-dependent city structure to more sustainable transportation systems is the instrumental step towards the goal of creating a sustainable city.
Transport infrastructure is a powerful shaper of cities and their urban forms (Cervero, 1998). As shown in figure 1.1, depending on the choice of transportation modes, capital investment will be directed to either suburbanization or redevelopment of the inner city which intern lead to sprawled and automobile oriented or compact and transit oriented development patter respectively. Urban form is a ‘path dependent’ process determined by investments in transport infrastructures and modes and physical constraints of local environments (Rodrigue, 2009). Globally, commuting time has remained stable from 1 to 2 hours per day though travel distance increases as a result of decentralization of activities and increased usage of automobile. On the other hand, transport has also a profound effect of structuring the urban form through clustering of activities near areas of high accessibility. Different transport technologies have different travel speeds and capacity thus giving cities different forms in the process. Transport technology plays a major role in defining urban form and determining the spatial arrangement of activities (Rodrigue, 2009).

1.1.2 Research problem
The city of Addis Ababa is striving to bridge the gap between the transport demand and supply and in response to this, large scale road projects are underway to improve the quality and capacity of the existing road transport infrastructure and hence the service provision. Experiences in both developed and developing cities show that investments on road infrastructures are both the problem and solution providers to the expectation of relieving excessive congestion (Rodrigue 2009). Construction of auto-oriented road infrastructures encourages car use and ownership which intern results in
congestion of the new highways or roads in a matter of time. The conventional way of planning and designing urban transport infrastructure result in the vicious circle of congestion as this practice will be accompanied by a rise in the use of car and need of more roads. The challenge is what paths can be followed in Addis Ababa? Private transport (cars, highways, roads, interchanges, motorways) or public transport (buses, trams, trains). The city is at a crossroad in terms of the choice of transportation priorities that set the direction and framework for future development. Given the low performance of the transportation system in Addis Ababa and the trend it is practicing, as much as the infrastructure and service provision requires improvement, it also needs interventions to accommodate wide range of road users and to shape the urban environment of the city for the better. Both the road network infrastructure and transport service provision need desperate adjustment in planning, designing, management and operational practices.

1.1.3 Research Questions

A. What are the real and perceivable challenges of the city of Addis Ababa in the contemporary practice of urban transport system? What type of transport infrastructure and urban developments are practiced in the city and how compatible and competent these practices are to the current and future challenges of the city?
   o How compatible the current practices of road infrastructures are with the objective of providing accessible transport modes for all groups of road users?

B. To what extent does the provision of integrated public transport networks guide the development practice in cities and affect the overall built environment and what lessons can be learnt from the experience of the city of Stockholm?
   o What are the effects of conventional transport planning? What is the alternative?

C. What planning approach need to be practiced to integrate public transport and urban planning and how can the street network be designed at city and neighborhood scales to address the principles of sustainable accessibility?
   o What are the benefits and challenges of accessibility-based transport planning?

1.2 Purpose, Aim and Objective

The primary purpose of the thesis is to highlight the role that public transport networks play in shaping the built environment of cities and their metropolitan areas. The paper tries to examine the experiences of cities that have managed to integrate urban planning with public transport and how that knowledge can be used
in the planning of new cities and redesigning of existing ones. Designing of livable and sustainable cities requires the integration of urban planning with public transport networks. In light of this, the thesis focuses on highlighting the importance of building a city around transportation system as a key element or indicator for sustainability as urban transport pattern set the framework and dictates future development. The aim of the thesis is to show how the choice of transportation systems affects urban form and the process that leads to either unsustainable practice of sprawling or to the socially and environmentally reduced impacts of compact cities.

The specific objectives of the thesis are to:

- Highlight the role of integrated urban development practice to absorb the current and future challenges of the city of Addis Ababa
- Study the experience of public transport and urban planning in the city of Stockholm and draw lessons that are contextually applicable to improve the respective practice in Addis Ababa
- Offer alternatives for transport planning practice in Addis Ababa and suggest holistic road network planning and design approaches/strategies for integrating public transport and urban planning

1.3 Theoretical framework

The theoretical framework stems from the idea of planning of a city around its transportation system by using transit-oriented development (TOD) as planning tool and accessibility-based transport planning as planning principle. TOD is a practice of compact and mixed use developments that are configured around pedestrian-friendly transit corridors. Setting public transport networks as backbone of a city forms the conceptual framework for this study and the perspective lies in the underlying concept of designing integrated public transport networks as the heart of the city’s hardware for achieving better social equity, sustainable accessibility and reduced environmental footprint. PT networks/transits are the central elements of TOD which together provide the hardware of sustainable urban regions. Transportation corridors are the building blocks that shape the urban form which intern sets the spatial pattern of activities and interactions (Rodrigue 2009; Farr 2008). It is obvious that several socio-economic factors interplay to govern both the form and the manner in which cities develop. Given the discourse of sustainability and the mounting challenge of climate change, urbanization, and peak oil, the design of current and future cities around well served transportation corridors has overarching roles to achieve the multiple objectives of environmental, social and economic sustainability. At a city scale, sustainability demands the shaping of cities from auto- oriented system to public transport-oriented pattern to reduce the impacts of urban sprawl, social externalities, energy and land consumption which arise as result of unsustainable transportation patterns and housing choices.
Accessibility - here in defined as the ease or possibility of reaching a desired destination from a given point in a space by a certain mode of transport and the principles of TOD make the theoretical framework upon which this research is based. The concept of accessibility can be used as a useful framework for integrating transport and land use planning (Bertolini et al, 2005). TOD is a strategic planning instrument by which the concept of accessibility can be operationalized by integrating public transport networks and built environment. Accessibility-based transport and urban planning is used as a conceptual framework and research guiding principle. Approaching transport and urban planning practice from the perspective of accessibility enables to address the three dimensions of sustainability. Accessibility is related to social goals (access to employment, goods and services and social interactions) economic goals (access to workers, customers, suppliers) and environmental goals (space and resource-efficient activity configuration and mobility patterns) (Bertolini et al, 2005). These goals can be achieved by practicing TOD as it works both on the transport and urban form of the equation to address the issues of destination accessibility and environmental footprint.

Figure 1-2 Research guiding principle

1.4 Methodology

Accessibility-based transport and urban planning is set as conceptual framework to evaluate the contemporary practice of urban transport infrastructure planning and design practice in Addis Ababa. The role of public transport technologies and the prospect of transit oriented development (TOD) are discussed in relation to their potential of reshaping the urban environment of a city. In particular, the cases of the newly started Bole road in Addis Ababa and the experience of transit oriented neighborhood of Stockholm are explored from the perspective of accessibility, complete street design and placemaking.

The concepts of complete streets and placemaking are closely related to key goals of accessibility and they complement each other. Complete street design refers to the appropriate representation of different modes at street level. The concept of placemaking which is the design of attractive and accessible urban environments is used in the context of the wider perception of streets as roads/space. Setting
accessibly, complete street design and placemaking as key indicators of integrated public transport networks and built environment, the case-based research approach explores the potential of transit technologies and impact of urban transport infrastructures on local and citywide accessibility.

Figure 1-3 Research Design

The above figure shows the procedure followed in conducting the research. The research is designed on the basis of comprehensive literature review which is used in the formulation and identification of real world problem. The concepts are then synthesized and operationalized in practical case studies to construct theoretical framework that serves as research methodology and guiding principle.

Theoretical background
- Public Transport and Built environment
- Urban transport infrastructure
- Accessibility and Urban form

Integrated public transport and urban planning

Case Studies:
- Addis Ababa-Bole road
- Stockholm-TOD neighborhood

Research focus areas
- Public Transport
- Transport infrastructure
- Built environment

Research findings

Conclusion

Recommendation

Contextual background
- Addis Ababa profile
- Public transport system
- Urban planning practice
1.5 **Scope and relevance of the study**

The scope of this research is limited to the relation between public transport and built environment and the role that transit technologies/systems play in shaping the built environment of cities and their metropolitan regions. The paper revolves around transport infrastructure planning practices, urban form (physical elements of built environment) from the perspective of creating accessible and sustainable urban environments. However, various socio-economic and demographic factors, cultural priorities and preferences that collectively underpin the urban fabric and the resulting travel patterns are not included in this paper as the research is limited in its extent and perspective to the particular case of Bole road within the domain of transport infrastructure planning.

The research will be relevant for improving public transport and urban planning practice in general and in particular it is expected to benefit the following spectrum of target groups (public authorities, decision- makers, organizations and professionals):

- Addis Ababa Transport Authority (AATA) and Addis Ababa City Bus Enterprise can make use of the document to strengthen the role of public transport and to design strategic urban planning around the prospective LRT and BRT lines and other main transportation corridors of the city.
- Addis Ababa City Road Authority (AACRA) will find it useful to improve the current practice of road design and planning so as to design complete streets-roads with dedicated bus lanes and adequate pedestrian facilities.
- Professionals and practitioners in respective disciplines (architects, urban planners, and engineers, individuals and private companies) engaged in local planning of urban centers and city development will also benefit from this research.

1.6 **Summary of findings**

The general findings of the research show that the provision of adequate pedestrian facilities, cycle paths and bus lanes is given less priority in existing road network of Addis Ababa and in the design of new transport infrastructure. This is also reflected in the case study of the new Bole road as the new 40m wide highway has many disadvantages when evaluated from the perspective of accessibility, complete street design, and placemaking. The comparison of alternatives (Table 6.1) shows that the road would have high prospect of complementing the LRT and BRT network and reducing the perceived congestion if the BRT proposal was selected. On the other hand, the 37.5 m wide transit corridor of Stockholm provides high ridership, better accessibility and placemaking through the design of compact and mixed use developments and pedestrian friendly street design.
1.7 **Organization of the thesis-structure of the paper**

The paper is organized in 7 chapters and the content of each chapter is briefly described as follows.

Chapter 1- Introduces the content of the paper, general problem field of the study, identifies research problem, defines research questions and objectives, and highlights the theoretical framework, methodological design and summary of research findings.

Chapter 2- Briefly defines indicators of integrated public transport and built environments and assesses transit technologies and transport planning paradigms

Chapter 3- Describes the contextual setting of the transport problems in Addis Ababa and the city’s profile. The current state of urban transport and ongoing and future transport projects/plans, city expansion, contemporary development practices and urban challenges of the city are described in this section.

Chapter 4- Presents the research methodology and materials used for the study.

Chapter 5- Case studies- Briefly describes the cases of Addis Ababa’s Bole road and the LRT-based TOD neighborhood of Stockholm.

Chapter 6- Discusses research findings and analyses of the case studies on the basis of the identified indicators.

Chapter 7- Discussion, concluding remarks and recommendation
2 Defining indicators of integrated public transport and built environment

2.1 Introduction

Cities are places of change at a larger scale due to various social and economic activities all of which are dynamic in nature. The complex processes propel the development of cities both across space and time. At the heart of city structure lies the urban transport system that defines both the nature of the built environment and the complex processes emancipating from the urban fabric. Transport is the engine of urban life that propels the day to day social and economic activities of cities and driver of global economy at a larger scale. Accessibility and mobility as function of transport system have played an integral role in shaping the urban form of cities, influencing the location of social and economic activities and are determinants of economies of scale (Abreha, 2007).

The need for integrated public transport and urban planning is widely acknowledged to counterbalance the growing challenges of a rapidly urbanizing world (Farr, 2008; Cervero, 1998). Public transport-oriented transport infrastructures and compact urban form can address the multifaceted challenges of urbanization, climate change, urban sprawl and unsustainable environmental practices and energy consumption. Public transport is an integral part of sustainable transport development plans, and has become a central issue in transport planning (Abreha, 2007). As a consequence, there is a growing need of strengthening the role of public transport both in developed cities where there is competent and quality service provision and in developing cities where there is poor service provision and a considerable gap between supply and demand.

Though sustainability has broad spectrum of discourses, at the heart of it lies efficient utilization of natural resources to maintain social and economic development now and in to the future. A development that recognizes the scarcity of resources (land, water, energy, material…) and that which is geared to social well-being is sustainable. The integration of transport and land use planning is a key issue of sustainable development (Farr, 2008; Bertolini et al, 2005; Toth, 2011). Apart from their role of catalyzing social and economic activities of cities, transit corridors are back bone of urban structures that can dictate future developments and can thus be used as framework around which sustainability can be built. In light of the quest of sustainability and its versatile interpretation, Douglas Farr managed to describe sustainability in a more practical and perceivable way when he defined sustainable urbanism as ‘high performance infrastructures and buildings’ that are walkable and transit oriented (Farr, 2008:42). Integrating transport systems (bus, BRT, LRT and metros) and functional land use activities forms the core element of sustainable urbanism (Farr, 2008). Cervero (1998) used the terms density, diversity and design to
describe the type of urban environments that are transit supportive which respectively correspond to compact, mixed-use and pedestrian-friendly built environments according to the Congress for New Urbanism (CNB) (Farr, 2008).

2.2 Accessibility -Perspectives and definitions

A wide range of definitions are given for the term accessibility. There is no universally agreed definition of accessibility (Abreha, 2007) and there are broad spectrums of scientific fields (urban planning, transport planning, geography, IT etc.) and perspectives from which the concept is addressed (Geurs and van Wee, 2004). The definitions and interpretations of the term vary depending on the intended purpose and area of application. To show the flexibility and diverse usage of the term, Abreha (2007) quotes Gould’s (1969) expression of the concept “accessibility … is a slippery notion … one of those common terms which everyone uses until faced with the problem of defining and measuring it”.

In the realm of transport planning and policies, the term is used in two different contexts; when referring to people’s “closeness” to public transport and disabled person’s capabilities/competencies to use public transport (Kottenhoff, 2012). The latter is an issue of public transport vehicle design (low floor decks and its supportive facilities (docking, ramps etc.) which makes it suitable/accessible for people of limited flexibility and mobility (disabled, elderly and people with babies in trolleys). On the other hand, proximity/closeness is a function of distance which can be explained by spatial arrangement of public transport infrastructure and the built environment and is a question of how far it is from living place to a nearby bus stop/transit station. However, proximity alone does not explain the concept in the whole of its entirety as accessibly is question of land use diversity and how well the built environment is designed to maximize accessibility. A grid pattern, walkable and interconnected network of streets with high intersection density enabled with broad spectrum of destinations greatly enhances accessibility. On the other hand transport infrastructures like highways, roads and interchanges can be both facilitator and inhibiter of accessibility depending on whether they are designed for all groups of road users or just for vehicles. A change in transportation technology or land use alters activity patterns which in turn affect the overall levels of accessibility (Rodrigues, 2009) (figure 2.1).

A compact urban form served by a well-designed public transport system offer higher level of accessibility. On explaining the notion of accessibility, Rodrigues (2009) underlines that accessibility is a key element in transport planning and is linked with an array of social and economic opportunities whose level of accessibility are
dependent on distance to destinations and location of transport infrastructure and urban density as shown in the figure 2-1.

According to Rodrigue (2009), at constant accessibility/distance, urban density is the determining factor that affects the availability of social opportunities (access to services and goods, employment and social interactions) and economic opportunities (access to customers and suppliers). At constant accessibility, an urban area of high built-up density will have higher level of accessibility than a low density area and vice-versa (Rodrigue, 2009).

Accessibility is an important indicator of how well public transport and the built environment are integrated to each other. The concept of accessibility- here in defined as the ease or possibility of reaching a desired destination from a given point in a space by a certain mode of transport- can be used as a useful framework for integrating transport and land use planning (Bertolini et al, 2005). Setting travel purpose, travel time and travel cost as the underlying bases of the concept, Bertolini et al (2005) defined accessibility as: “the amount of and diversity of places of activity that can be reached within a given travel time and/ or cost”. Geurs and van Wee (2004) describe it as the extent to which a transport system facilitates people’s participation in activities. And focusing on passenger transport, Geurs and van Wee( 2004) go on to define accessibility as: “the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)”. People, transport system and land use activities makeup the main components of accessibility (Geurs and van Wee, 2004; Geurs,2006; Abreha, 2007). Abreha (2007) highlights that accessibility is a much broader concept than mobility that can describe travel pattern entirely and defined it as “mobility for opportunities”.

Figure 2-1 Relationship between Distance and Activity Opportunities (left) and Transportation and Land use nexus (right)

Source: Rodrigue (2009)
Accessibility is a function of qualities of transport system (waking distance, travel time) and qualities of land use diversity (functional mix of activities and densities) (Bertolini et al, 2005) and the integration of the two systems determines the extent to which a desired destination is accessible from a given point of reference. Elements of the built environment like road network, street design, building density and land use diversity are some of the important parameters that affect the level of accessibility. A well-designed urban environment and efficient transport system provide higher level of accessibility in comparison to a less developed area (Rodrigue, 2009). As shown in figure 2-2 at heart of accessibility lies the transport system which connects people to desired destinations (work, school, recreation, shopping, and services of various kinds) which are functions of lad use diversity. Thus, accessibility is a broader concept that incorporates mobility, proximity and connectivity due to interaction of people with transport system and land use activities.

Shifting the focus of urban transport planning from mobility catering to accessibility catering through the practice of sustainable transport systems (PT, walking, cycling, shorter car trips) and supportive land use conditions (dense and diverse activities) provides a competitive/higher degree of accessibility than the less sustainable options of the car oriented and spatially-disjointed development patterns (Bertolini et al, 2005). Thus, accessibility is also a question of having variety of transportation options (bus, train, cycle, walk, and car) to reach a place of desired destination. The integration of transport interfaces (PT, walking, cycling, and driving) in a compact urban form of diverse activities/destinations in transit oriented development makes TOD to be a blueprint of accessibility. The desire for improved accessibility resulted in a rebirth of the development trend called TOD which supports urban living and transportation choices in an efficient use of land space (Farr, 2008:114). Common measures of accessibility include walking distance and travel time from origin to destinations (from living place to CBD, nearby shop/school or transit station).

2.3 **Urban space quality -Placemaking**

Cities are about places and people. Cities are known for the attractive places they can offer to their citizens and visitors. The sense of place and experience is what remains
in the minds of people once a place is left. Placemaking which refers to the art of creating attractive public spaces is an important indicator of integrated transport and urban planning. Public spaces include streets, sidewalks, and parks, transit stations/stops, building premises, green areas and open spaces of various kinds. Public spaces are places of memories, and stories and important meeting places where moments of experiences are created and shared. They are places where we discover our needs and aspirations. Access & linkages, sociability, use & activities and comfort& image are the four key elements/qualities of successful placemaking that Project for Public Spaces (PPP) has identified after researching and evaluating thousands of public spaces around the world. Successful public spaces are accessible, sociable, and have mix of activities and a comfortable space and good image (PPP, 2010).

Walkable and complete streets improve the quality and vibrancy of urban environments by attracting social events and economic activities and hence give life to the place where we work, play and live. Approaching transport planning and designing work from the perspective of placemaking helps to integrate transport and land use activities (Toth, 2011). In light of this, Gary Toth states the principle of placemaking as: “If you plan cities for cars and traffic, you get cars and traffic. If you plan for people and places, you get people and places” (Toth, 2011).

Apart from enhancing mobility and accessibility, light rail transit (LRT) and bus-based public transport have an important function of revitalizing city centers. The placemaking of light railways and bus ways lies on either sides of the transit corridors which offer two linear and elongated cores of highest attractiveness (Stojanovski et al, 2012).

Figure 2-3 Light railways and their placemaking
Source: Project for public space (PPP)
The longitudinal place making of light railways/bus ways changes the look and feel of the open urban space and creates mobile, safe and vibrant street life (figure 2-3). The adaptability of modern trams/light railways to run on reserved right of way (ROW) and/shared streets makes them suitable for placemaking. The integrity of light railways with urban streets can also be enhanced by greening the space between the rails. The vibrancy and liveability that light railways and bus ways bring to the cities is, however, limited to urban centers and are not competent with cars at regional scale since their average operating speed is in the range of 15 to 20 km/hr (Stojanovski et al, 2012). Stojanovski et al (2012) argue that apart from being regionally incompetent, light railways and bus ways are partly permeable and partly barriers (where they have segregated ROW) and within the perspective of regional accessibility, high speed public transport networks like metros and trains are required to regionally compete with cars.

2.3.1 The realm of urban space – streets as space

The quality of the urban space has been greatly compromised by providing urban spaces that are exclusively designed for cars. Streets are seen as spaces for cars at the expense of public space. Banister (2008) argues that transport policy measures that encourage modal shift should be in place to make the best use of the free or “released space”. The perception of designing street for cars need to be changed from the outset as it is no longer perceived only as a road but also as space for people, green modes (walking and cycling) and public transport (Banister, 2008; Toth, 2011). Streets are public spaces too. They are important breathing and refreshing places.

Cars are masters of highways and streets in motorized cities of America. The motorization trend is also gradually expressing itself in developing cities like Addis Ababa. Cars outplaced public spaces and pedestrian friendly streets as they take up larger area of the road space for driving and parking. This is a typical feature by which the city of Addis Ababa is characterized. The urban fabric is very tight and the streets and roads are narrow making it difficult for fast and free movement of traffic. And in response to growing number of cars in the city, roads are being widened to accommodate more and more cars at the expense of public spaces. The newly started Bole road is the recent example of this reality. Although urban open spaces have been incorporated since the first master plan of the 1940, the proposals for public spaces were left at a paper level due to less priority for public spaces and various implementation problems (Aragaw, 2011). Most of the open urban spaces are becoming part of a big city as they are being taken over by buildings and roads (Aragaw, 2011). People are being penalized for not having the car. Social groups who are too young and old, disabled and too poor or those who can’t afford to buy a car will be externalized as they will be deprived of having equal access to transportation,
clean urban environment, and free public space. Providing public transport networks (transits) is also instrumental for exercising social equity and for conquering the released space, *urban streets*.

### 2.4 Complete streets

Streets are important elements of the built environment that affect destination accessibility at neighborhood, urban/city and regional scale. Sustainable transport and hence greater accessibility and transportation alternatives are achieved when transportation networks and street patterns are properly designed at street level (Omari, 2010). Complete streets are designed to accommodate all travel modes—walking, cycling, public transport, and cars and are distinguishing features of integrated transport and built environments. Changing the practice of transport planning from the design of road on the physics of moving vehicles to multimodal and context-based street design enables to integrate transportation and land use as the former has been marginalizing pedestrians, cyclists and PT users and separating streets from adjacent land use activities (Farr, 2008). Gary Toth also highlights that “*land use that favors mobility and cars over accessibly and places is no longer viable*” or sustainable as the focus on high mobility underestimates the non-motorized transportation and public transport networks that are important for revitalizing city centers (Toth, 2011).

Complete street entail the principle of designing streets with all groups of road users in mind so that they can have variety of transportation choices. At a city and neighborhood scale, having sidewalk on both side of the street network across the entire length increases neighborhood and urban interconnectivity (Farr, 2008).

The integration of transportation and land use requires the coupling of community-based policies and programs from the respective domains (Toth, 2011). And the coupling of transportation policies with land use policies can be realized through the frameworks of complete street design and compact and mixed-use developments that enhances the functionality and livability of cities in general and urban streets in particular. A well-designed complete street encompasses the following elements (Farr, 2008:154)

- Multimodal (transit, walking, cycling, driving)
- Compatibility with adjacent land uses/mixed use
- Compact and walkable neighborhoods
- High quality public spaces and aesthetics
- Environmental quality (green strips, trees)
2.5 Public Transport performance Indicators

Performance can be measured on the basis of predetermined set of social, economic and environmental goals/targets for which a public service is designed. Performance measures are usually policy-driven and involves tradeoffs in options and decision-making (NCHRP, 2005 cited by Abreha, 2007). On the basis of economic terms, public transport is far from performing well both in the developing and developed countries as it is heavily subsidized except in Asian countries like Japan. Even in transit oriented European cities more than 50% of public transport operational costs are subsidized by government taxes (Rodrigue, 2009; Kottenhoff, 2012). Measuring the performance of public transport on the basis of social goals (access for opportunities and equity) requires the setting of social indicators.

Public transport entails social function as main purpose as it provides accessibility and social equity (Rodrigue, 2009; Kottenhoff, 2012). The basic political argument for public transport is providing transport access for all citizens so that they can travel to participate in various life activities such as work, school, recreation and services of various kinds. The fundamental principle of PT is providing access to all groups of society and is an important instrument of ‘distribution policy’ (Kottenhoff, 2012). It tries to exercise social equity/justice by providing transport access to all groups of societies at reasonable cost and in particular to regular customers and disadvantaged groups of society (women, students, school children, the elderly and disabled) and to those who cannot drive or own a car.

In a general context, performance indicators of sustainable transport system can address the following questions (The center for Sustainable Transportation 2002 cited by Abreha, 2007).

- Is the social (health impact) and environmental performance of transport system improving?
- Are land use, urban form and transportation system changing so as to reduce the demand for transportation? /Are we creating accessible cities?
- “Are we increasing the efficiency of the current transport infrastructure and changing the infrastructure supply in a sustainable way?”
- Are the development practices and investments by governments, companies, and other actors coordinated and consistent with objectives of sustainability and accessibility?
2.5.1 Public Transport service quality Indicators

Performance indicators of public transport can be grouped in two sets of measures: quality of service and service efficiency and effectiveness (Kottenhoff, 2012). Quality of service refers to the overall measures and perceived performance of PT from passenger’s point of view. It covers various service aspects ranging from measurable entities like walking distance, waiting time, travel time, availability and reliability to more qualitative aspects like comfort and safety (Kottenhoff, 2012). The total journey time is broken down into walking time/walking distance, waiting time and travel time. These quantifiable measures of PT have built environment dimensions and are important indicators of how well PT and built environment are integrated.

**Walking distance** refers to the distance from home/work place to a nearby transit/bus stop. It is an indicator of service coverage area (Abreha, 2007) and is one of the most important factors that affects/influences people’s decision of using public transport (Kottenhoff, 2012). A walking distance in the range of 300-500m radius is considered as comfortable walking distance. In low density areas, a walking distance in excess of 500m is acceptable but the maximum should not exceed 1000m (Armstrong et al, 1987 cited by Abreha, 2007). A place of good accessibility has good street design and shorter trips to destinations.

**Waiting time** - The time passengers spent at transit stops/stations waiting for a bus/train. The waiting time is perceived as the most inconvenient/or ‘heavy’ part of the whole journey time. A well-designed bus stop (availability of seats, shelter, information display, telephone, presence of café at close range etc) can reduce the inconvenience of waiting time. The waiting time is an indicator of the frequency of a bus/train. To attain acceptable level of service, the average waiting time in developing countries should be in the range of 5-10 minutes, however, depending on the prevailing conditions of PT, it is extended to 10-20 minutes of maximum waiting time (Armstrong et al, 1987 cited by Abreha, 2007).

**Travel time** - The time taken from origin to destination while riding (in-vehicle/onboard time). The green standard for acceptable travel/riding time can be 30 minutes or less (Kottenhoff, 2012). Important regional destinations like universities/high schools, major working places, central business districts (CBDs) and medical centers need to be considered in the analysis of travel time.

2.6 Integrating transport and urban planning, Cities and sustainable urban transport

2.6.1 Transportation and the urban form

Cities that primarily rely on public transport and non-motorized modes have different urban form than the auto-dependent cities (Rodrigue, 2009). The contrasting urban
Forms of American and European cities are just a reflection of the respective choice of mode of transportation which gave rise to the sprawled and compact urban form in the former and the latter respectively. Studies on the relation between urban form, mode of transport and energy use by Newman and Kenworthy (1999) have shown that the lower density American cities have higher level of car and energy use per capita than the compact and high density European cities as shown in figure 2-4.

Transport technology plays an important role in defining urban form (Rodrigue, 2009; Newman and Kenworthy, 1999). Cities that strive to reduce auto-oriented development patterns must create transit spine along major urban corridors and direct the urban planning work to focus around the key urban nodes along the transit spine (Newman and Kenworthy, 1999). Newman and Kenworthy (1999:189) remarks that ‘sustainable city’ of the future is one that promotes accessibility through the provision of balanced transport modes and mixed land use in a transit and walking oriented urban villages. Based on their transportation pattern, Newman and Kenworthy (1999:190) classified cities into four types: walking city, transit city, automobile city and sustainable city (Table 2.1). The ‘sustainable city’ is the hybrid of the first three cities with transit as a backbone, car as supplementary and higher proportion of waking and cycling.
Table 2.1 City types and transportation patterns

<table>
<thead>
<tr>
<th></th>
<th>Traditional Walking City</th>
<th>Industrial Transit City</th>
<th>Modern Automobile City</th>
<th>Future Sustainable City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Walking and (cycling later)</td>
<td>Trams and trains (also waking and cycling)</td>
<td>Cars/almost exclusively Transits(regional) in and across city, cars (supplementary)</td>
<td></td>
</tr>
<tr>
<td>Urban form</td>
<td>Walking City Compact and mixed, organic</td>
<td>Transit City dense mixed center medium density suburban, corridors with green wages</td>
<td>Auto City high rise CBD low density suburban sprawl and separated city function</td>
<td>Sustainable City High density and mixed urban cores linked by transits, surrounded by medium to low density areas No more sprawl</td>
</tr>
<tr>
<td>Environment</td>
<td>Resource use and waste</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Nature</td>
<td>Close to rural areas/dependent</td>
<td>Some connection through green wages</td>
<td>Little nature</td>
</tr>
</tbody>
</table>

Source: Newman and Kenworthy (1999:190)

The city of Addis Ababa does not have a well-designed urban framework in the form of rail transit or high capacity transit corridors that can guide the development of the city in a controlled and planned fashion. Recent urban expansion in the city which is characterized by massive single family real estate projects is an automobile demanding development path. Such development patterns need to be intercepted through densification schemes in order to protect the city from further sprawling whose consequences are reduced accessibility, increased travel distance, high energy and land space consumption. The replicating of such urban development practices also makes the provision of public transport infrastructure costly and very difficult as it is usually accompanied by displacements that are not socially welcomed. The city has to be built inwards using the proposed and the newly started light rail transit (LRT) spines as backbone of the city structure and only then the city of Addis Ababa can begin to take an urban form that is compact and transit supportive. Given the high density of population (75 inhabitants/hectare) in Addis Ababa, it is plausible that a certain urban corridor can have an acceptable level of patronage. However, this can be strengthened by densifying built environment of the inner city to better suit the demands of PT so that it becomes cost effective and more accessible. Denser built environments around PT networks will increase the level of patronage and have great potential of lowering the unit cost of providing decent quality of PT service (Newman and Kenworthy, 1999).
2.6.2 Public Transport Technologies

Sustainable metropolitan city regions are created around high-performance transit corridors (Farr, 2008). These transit corridors include buses, LRT, BRT, trains and metros. They play an important role in connecting regional destinations, providing circulations and revitalizing city centers through the propagation of transit-oriented development (TOD). The different types public transport technologies/systems have their own specific use, capacity, operating speed and other operational and vehicular characteristics (Table 2.2).

Table 2.2 Public Transport/Transit Technologies

<table>
<thead>
<tr>
<th></th>
<th>Bus</th>
<th>Articulated Bus</th>
<th>BRT</th>
<th>LRT</th>
<th>Commuter rail</th>
<th>Metro (heavy rail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost* ($ Million/km)</td>
<td>0.25-1</td>
<td>0.5-1.25</td>
<td>2.5-35</td>
<td>15-40</td>
<td>1.75-15</td>
<td>30-155</td>
</tr>
<tr>
<td>Service area</td>
<td>Regional/urban</td>
<td>Regional/urban</td>
<td>Regional/urban</td>
<td>Regional/interurban</td>
<td>Suburban</td>
<td>Regional/urban</td>
</tr>
<tr>
<td>Station spacing (m)</td>
<td>300-500</td>
<td>300-500</td>
<td>500-800</td>
<td>500-800</td>
<td>2000+</td>
<td>800-2000</td>
</tr>
<tr>
<td>Maximum speed (km/hr)</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70-80</td>
<td>80-130</td>
<td>80-100</td>
</tr>
<tr>
<td>Operating speed (km/hr)</td>
<td>10-20</td>
<td>10-20</td>
<td>20-35</td>
<td>20-30</td>
<td>40-70</td>
<td>25-60</td>
</tr>
<tr>
<td>Service frequency (min)</td>
<td>3-10</td>
<td>3-10</td>
<td>3-10</td>
<td>5-15</td>
<td>15-30</td>
<td>5-10</td>
</tr>
<tr>
<td>Vehicle characteristic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Length (m)</td>
<td>12</td>
<td>18</td>
<td>15-25</td>
<td>14-32</td>
<td>20-26</td>
<td>16-23</td>
</tr>
<tr>
<td>Width (m)</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.4-2.65</td>
<td>2.5-3</td>
<td>2.5-3</td>
</tr>
<tr>
<td>Vehicle/train Capacity</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1-4</td>
<td>1-10</td>
<td>1-10</td>
</tr>
<tr>
<td>Passengers/vehicle</td>
<td>80-100</td>
<td>115-150</td>
<td>150-200</td>
<td>200-250</td>
<td>180-200</td>
<td>250</td>
</tr>
<tr>
<td>System Capacity (Pass/Hr/Direc.)</td>
<td>1,000-2,000</td>
<td>1,500-3,000</td>
<td>2,500-15,000</td>
<td>2,000-15,000</td>
<td>10,000</td>
<td>10,000-30,000</td>
</tr>
<tr>
<td>ROW</td>
<td>Mixed/bus lanes</td>
<td>busways</td>
<td>Shared/-separated Overhead wire</td>
<td>ROW</td>
<td>Separated</td>
<td></td>
</tr>
<tr>
<td>Power source</td>
<td>Diesel/hybrid/biofuel</td>
<td></td>
<td>Dies./Hybrid 3rd rail</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: (Farr, 2008)*,(kottenhoff, 2012)

The advantages and disadvantages of the different PT/transit technologies have social, economic, environmental and locational perspectives. LRTs and/BRTs are more appropriate and cost-effective than heavy rail if a city is planning for re-urbanizing
city centers and for circulating in and around (Farr, 2008). Commuter trains are more effective and faster to bring workers from suburbs, whereas metros/subways are competent for linking important regional destinations and urban cores. And buses are competent in both urban and suburban areas and especially in areas that are practically inconvenient for mass transport systems. Every mode of public transport excels in its own domain and it is, therefore, the integration of the various PT modes that makes accessible and effective transportation possible at local, urban and regional scale.

2.7 Transport planning: Infrastructural and service requirements of public transport

2.7.1 Urban transport infrastructure planning – Conventional vs Sustainability Paradigm

Approaching urban transport infrastructure planning from the perspective of accessibility is instrumental in the process of creating livable and sustainable cities. With congestion being the main problem in the streets of cities like Addis Ababa; urban planners, engineers and authorities are entangled in the conventional way of designing roads for mobility catering. The recently started Bole road of Addis Ababa is a typical example of conventional transport planning where a 40 m wide and 8 lanes road is designed in favor motorized transport rather than public transport and non-motorized modes. Banister (2008) argues that ‘physical dimensions’ (traffic flow, urban form, roads) are the primary concerns of conventional approaches of transport planning and this should be balanced by the ‘social dimensions’ (peoples, places and proximity) to enhance the accessibility and sustainability of cities as illustrated in Table 2.3.
Designing of sustainable and livable city requires the change of focus from conventional practice of mobility-based road planning to accessibly-based transport planning so that better activity coupling can be achieved through complete street design and mixed use land policies (Toth, 2011; Farr, 2008). Bertolini et al (2005) states that “A shift of focus in urban transport planning from catering for mobility to catering for accessibility may help see how more sustainable travel options (e.g. walking, cycling, public transport, shorter car trips) can, under certain land use conditions (e.g. higher densities, more finely-tuned functional mix) provides a competitive degree of accessibility that matches less sustainable options”.

A comparison of approaches to transport planning (Conventional vs Sustainable accessibility) shows that in the former case, the car is the primary focus and as a result people and streets are separated from adjacent land use activities while the latter approach strives to strike a modal balance through the integration of transport and land use and prioritization of PT, walking and cycling (Table 2.3).

### 2.7.2 Public Transport planning

The spectrum for public transport planning ranges from long term (5-25 years) to medium term (2-5 years) and short term planning (1-2 years) (Kotttenhof, 2012). In response to the pressing demand of public transport in the city, the Transport Authority of Addis Ababa has set out the following short term and medium term plans with the long term to come in the foreseeable future.
**Long term- Metro**

**Medium term-** Addis Ababa Transport Authority has medium term plan of providing light rail transit (LRT) and bus rapid transit (BRT) with in the coming five years.

**Short term plan-** Expanding the capacity of city bus services with addition of normal city buses and the introduction of 100 articulated buses. Operations have already been started for the short and medium term PT planning.

### 2.7.3 Public Transport Networks

PT networks or interchangeably termed as transits are transport systems that provide public transport services on the basis of fixed routes and schedules. PT modes include trains, trams and buses operating on fixed linear routes connecting a number of stops in series that together form a network of transport systems the size and the capacity of which differs according to the particular mode and context. The primary purpose of PT is to provide better accessibility to working places, education centers and other important destinations. Accessibility is the ease with which a desired destination can be reached from a given point by using a particular mode of transport. The need for integrating PT networks and built environment stems from the importance of enhancing accessibility and not mobility. Both are function of distance but the latter is more associated with motor vehicle traffic use and often results in increased travel distance and demand as result of it supportive investments in road and highway project and segregated settlement patterns. Accessibility on the other hands demands interconnected network of streets, pedestrian friendly street design, reduced distance and directness to diverse destinations which arises from excellent integration of PT networks and the surrounding built environment. Conventional transportation planning has the tendency of expanding highway projects with the expectation of reliving congestion and other transport problems (Litman 2006). In comparison to the mobility-oriented transport planning, accessibility-based transport planning leads to mixed use and more accessible land use developments (Litman, 2006; Bertolini et al, 2005). Planners have the practice and options of evaluating transport either on mobility (movement of people and goods) or accessibility (the ease of reaching activities and services) (Litman, 2006).

Transit corridors that link neighborhoods together with central business districts (CBDs) and important regional destinations are the backbone of sustainable urbanism (Farr, 2008:46). Sustainable urbanism/urban development is tailored to revitalizing the existing/proposed transit corridors and densifying the adjacent land uses to support a robust level of bus, light rail services and BRT lines (Farr, 2008). The introduction of BRT corridors and LRT lines in the two major transportation corridors of Addis Ababa: the East-West axis and North-South axis have a high prospect of emerging as the backbone of the city’s future urban development. However, the proper functioning
of the urban transport system requires robust integration of the different hierarchies of public transport where the city buses and minibuses have to be used as feeders to the BRT and LRT lines. The newly introduced and upcoming articulated buses could play a complementing role in providing urban and regional accessibility. Transport accessibility at local, urban and regional level requires an integrated PT network that encompasses buses, light rails, commuter trains and metros. Every mode of public transport excels in its own domain. Stockholm is a good example where the different hierarchies of public transport are effectively coordinated to provide higher level of service and accessibility at all levels in the greater metropolitan area of Stockholm. The urban buses and trams circulate the city and are linked to suburban buses and commuter trains which all serve as feeders to the speedy metro to form a well-functioning and integrated public transport network.

2.7.4 Quality and Accessibility of stations and stops
Public transport is more than providing decent quality of transport infrastructure or selection of appropriate transit technology. People’s preference of particular mode of transport or perception of public transport use depends on various service quality factors. Apart from important parameters like travel time, walking distance, and waiting time, improving the quality of bus stations/stops is rewarding from passenger perspective. Accessibility of station can be enhanced through the design of compact urban environments and interconnect networks of streets at neighborhood and urban scale. A well-designed bus/train stops (availability of seats, shelter, information display, telephone, presence of cafe at close range etc) can make the waiting time more attractive and hence reduce the inconvenience/heaviness of waiting time. Transit stations/stops should not be perceived as just waiting places only. They are regularly used public spaces too and therefore need to be well equipped with important facilities (benches, weather protection, passenger information, lighting, cleanliness, and trash cans).

2.8 The case of compact cities and Transit Oriented Development
Neighborhoods are the building blocks of urban regions. The planning and design of well-functioning neighborhoods results in self-supporting urban centers the systematic network and activity-interaction of which forms sustainable cities. And it is when a city is planned around a well serving PT network that the system can keep on running for proper functioning of the vibrant motions of life at neighborhood and or regional scale. The practice of transit oriented development (TOD) greatly supports urban living and transportation choices by creating neighborhoods/urban districts within walking distance to transit stations that offer plenty of opportunities ranging from accessibility to broad spectrum of services, jobs and housing to reduced transportation costs or mobility demands (Farr, 2008).
TOD is a strategic planning tool by which public transport networks and built environment can be best integrated to form a sustainable urban region. It is a contemporary development practice characterized by compact, mixed use developments and a walkable network of streets that are configured around transit corridors. The clustering of high density mixed-use buildings creates walkable TOD neighborhoods which when lined up in series and connected to each other by PT corridors form sustainable urban regions (Farr, 2008; Cervero and Sullian, 2011). PT networks are the central features of TODs whose expansion dictate the location and form of urban development resulting in high demand of housing near to PT stations (Farr, 2008). The principle of TOD lies in the clustering of diverse activities of life with walking distance to bus/and train stations aiming at reducing the impacts of both transport and built environment. The inter-mixing of living, working, schooling places and other important destinations like shops, recreational centers, restaurants and vital public services around a well-integrated PT modes, cycle paths and pedestrian facilities greatly reduces the city’s environmental footprint arising from the uncontrolled settlement patterns and transportation choices. In short, the objective of TOD is making prime life activities accessible in an efficient use of land space where the surrounding environment is designed in such a way to make PT use, walking and cycling more attractive and enjoyable than driving the car. TOD is a practice of doing more with less.

2.8.1 Accessibility and functions of TOD

The essence of TOD lies in working both on the mobility and accessibility dimensions of the built environment. PT networks as central elements of TOD enable to reduce the impact of built environment by promoting compact development that maximize infill and minimize green field development and by increasing proximity and therefore reducing the energy demand for mobility (Dubarry, 2010). Apart from creating vibrant and active street life, the practice of TOD offers environmental benefits as it works on mobility with the objective of reducing vehicle kilometers travelled (VKT) which is directly related to energy consumption and GHG emissions (Cervero and Sullian, 2011). The clustering of economic and social activities mainly working and living places and other important destinations around transits contribute to significant reduction of VKT. The reduction in VKT comes not only from the shift of trips from auto-to transit modes but also from the replacement of trips to off-site destinations that would have been by car with onsite walking and cycling enabled by land-use mixes (Cervero and Sullian, 2011; Farr, 2008)
2.8.2 The D variables of the built environment and their relation to TOD and PT use

Transit supportive urban landscapes are primarily characterized by five D variables/elements of the built environment - density, diversity, design, destination accessibility and distance to transits (Cervero 1998; Cervero and Sullivan, 2011; Ewing and Cervero, 2010). TOD embraces the concepts of density, diversity, design as central features of the built environment and at the heart of it lies the transit itself in to which two environmental variables namely destination accessibility and distance to transits are added by Ewing and Cervero (2010) to study the relation between travel patterns and built environment. The five D variables of the built environment have close connection to TOD which is distinguished by the elements of compact development (density), mixed use (diversity), pedestrian oriented streets (design) and transportation interfaces (distance to transit and destination accessibility measures).

**Density**- refers to compact development or population size per unit area. The variable of interest can be population density, housing unit or more specifically building Floor Area Ratio [FAR] which indicates how dense an urban built environment is. FAR refers to the total floor area of a building divided by its resting land area/plot. Ratios below 1.5 are considered as low density areas (from detached-single storey houses to low-rise buildings) and areas with FAR ranging from 1.5 to 5 constitute dense urban areas (mid-rise to high-rise buildings). The densities of a typical European inner city have often a FAR of 1.5 to 2.5 (Vestbro, 2010). TOD relies on high density development and requires the densification of infill to maximize walkability and transit ridership. Efficient use of PT networks in TOD requires dense urban built environments.

**Diversity**-Mix of activities and services and encompasses the wide range of land uses in a given area. Mixed land use refers to the containment of various activities and proportion/availability of vital services like housing, jobs, shops, schools, libraries, medical centers and restaurants or recreational centers. In the context of TOD, diversity or mixed land use is about bringing destinations closer to each other so that they are within the range of walking distance. Walking is mostly associated with land use diversity, intersection density and number of destinations within the range of walking distance (Ewing and Cervero, 2010). This clustering of activities and services greatly reduces the demand for travel (mobility) as destinations are accessible within a stretch. And this is what TOD offers.

**Design** refers to street network characteristics/streetscape which includes physical variables that differentiate pedestrian oriented environments from auto-oriented ones, like width or proportion of walkway, street trees, and number of pedestrian crossings/intersection per km (Ewing and Cervero, 2010). Pedestrian oriented streets with public spaces, cycle paths and walkable and interconnected streets that are highly
accessible to and from transit stations are distinctive characteristic of pedestrian friendly street design in TOD. Pedestrians, cyclists and PT users are the centers of street design in TOD neighborhoods and streets are therefore designed to make them more convenient for this group of users than for car users.

**Destination accessibility**-is a measure of the ease of access to destinations/trip attractions which could be distance to CBD (regional) or distance from home to shopping center (local) which are higher at central locations and lowest at peripheral areas (Ewing and Cervero 2010). Studies by Ewing and Cervero 2010, on the relation between travel and the built environment has shown that VKT is most strongly related to primarily to destinations accessibility and then to street network design variables. Diversity and destination accessibility merge together in the case of TOD which makes TOD to play a great role to reduce VKT and environmental footprint at the same time.

**Distance to Transits** - corresponds to the distance from home or work place to bus or train stops /stations. A waking distance within the range of 500m radius or 5 minutes’ walk is considered as comfortable walking distance to bus or train stops. Out of the five D variables, bus and train use are more related to proximity to transit and street network design variables with land use diversity as a secondary factor (Ewing and Cervero, 2010). From this it is clear to see that transit ridership is a function of distance to stations, street network design and land use diversity all of which are blended in TOD neighborhoods.

As stated, TOD offers environmental benefits which comes from per capita VKT reductions as a consequence of the courtesy of more PT trips to out-of neighborhood destinations and more usage of non-motorized travel modes within the TOD (Ewing and Cervero, 2010; Cervero and Sullian, 2011). The combined effect of replacing car trips with PT and green modes has the potential to reduce the VKT per capita by an estimated amount of 40-50% compared to the conventional sub-urban development (Ewing and Cervero, 2010; Cervero and Sullian, 2011).

Cervero and Sullian (2011) argue that TOD is one of the most promising tools for breaking the viscous cycle of sprawl and car dependency as it helps to shift trips from the car to transit-based compact developments. The prospect of TOD lies in its capacity of integrating PT and built environment which results in reduced mobility and hence reduced energy consumption and environmental footprint.

TODs integrate transport and built environment in an efficient use of land space. PT network in TODs enable to promote polycentric city structures by creating self-supporting urban centers/satellites connected to each other by PT corridors and networks. Thus PT and TODs play a significant role in creating sustainable metropolitan city regions. However, urban forms created by TODs provide the
condition for sustainable living but do not guarantee that the activities taking place in these spaces are sustainable (Lundsrom, 2010). This argument is clearly explained and summed up by Lundsrom as “hardware” versus “software”. And Dubarry (2010) reinforces this by arguing that TODs are the “hardware” for sustainable urban regions and “software” constitutes what falls in the realm of society, politics and economics. In fact, the latter shapes the former but urban pattern in the form of TOD matters as it works both on the demand and supply side of transport and its energy consumptions and impacts of built environment at large.

The construction of mixed use buildings that comprises of residential and commercial buildings with a close proximity to stations offers wide range of opportunities to a broad spectrum of income groups (Farr, 2008). TOD addresses problems of excessive congestion, pedestrian oriented design, and more importantly the question of affordability and accessibility by tackling housing and transportation cost which are the long-run unanswered questions of majority of the inhabitants of city of Addis Ababa. Addis Ababa can take advantage of its basic urban structure; street-liners and in-fills to enhance compact development in the form of TOD. The practice of TOD will offer adequate pedestrian facilities to walking city of Addis Ababa as walking is the dominant means of transportation accounting for more than 55% urban trips on average. TOD has also the prospect of reducing the urban sprawl which is taking place as a result of the massive real estate projects at the outskirts of the city.
3 Addis Ababa City Profile and Urban Transport

Addis Ababa which means ‘New Flower’ is the capital city of Ethiopia and was founded by Emperor Menelik II in 1887. The city has been celebrating its 125th anniversary under the theme of “new spirit for Addis change” since the kick of the year 2012. Addis Ababa is the 4th largest diplomatic center in the world as it is a headquarter of UN Economic Commission for Africa (UNECA), African Union (AU) and a home of more than 90 embassies and various international organizations. The city is often referred as the “political capital of Africa” due to its historical, diplomatic and political significance for the continent. Addis Ababa is the heart of social, political, cultural and economic activities of the country and is one of the fastest growing cities in the world. It is a “primate city\(^2\) in the full sense of the term” (UN-HABITAT, 2007 as cited by Johnson, 2008). Located at the geographical center of the country, it is in continuous process of fast paced urbanization and is a home of around 5 million inhabitants (Hebel, 2009).

Addis Ababa lies at average altitude of 2500 m above sea level and has an expanded area of more than 540 sq.km. The city has temperate climate with average minimum and maximum temperature being 10 and 21° C. The city has three hierarchies of administration at the top of which lies the Addis Ababa City Government that is run by the City Council. The city is then divided in to 10 Sub-Cities and 99 smaller administration units called kebeles as second and third layer of administration.

The current population estimate of the city ranges from 3.5 to 5 million inhabitants, depending on who the source is. As per the UN-HABITANT 2007 report, the city had an estimated population of 4 million in 2007 (UN-HABITAT, 2007). According to Central Statistics Agency of Ethiopia (CSA), the reported population size of the city was 2.7 million in 2007 as per the population census conducted in 2005. However, the CSA’s (2005) estimate for the same year was 3.1 million (Abreha, 2007; Johanson, 2008). The medium population estimate and projection of the agency for years 2010 and 2015 are 3.75 and 4.6 million respectively (Meron, 2007). More than 50% of the city’s residents live under poverty line and 80% of the built up urban area is categorized as slum according to UN criteria (UN-HABITAT, 2008). However, this figure is reducing as the city has been undertaking re-development of downtowns and is striving to change its image through the propagation of large scale housing and road infrastructure projects. Transport is the engine of urban life that makes the proper functioning social and economic activities possible.

\(^{2}\)A primate city is the leading city in its country or region, disproportionately larger than any others in the urban hierarchy and on which the rest of the country depends for cultural, economic, political, and major transportation needs (Wikipedia)
Table 3.1 Addis Ababa City profile and Public Transport

<table>
<thead>
<tr>
<th>Category</th>
<th>City profile and Public Transport/PT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants</td>
<td>City 4,000,000 (UN -2007/8)</td>
</tr>
<tr>
<td></td>
<td>Metropolitan area 4,567,857</td>
</tr>
<tr>
<td>Areas</td>
<td>City Metropolitan area 540km²</td>
</tr>
<tr>
<td>Density</td>
<td>Metropolitan area 5750 inh/km²</td>
</tr>
<tr>
<td>Basic Urban structure</td>
<td>Street-liners and In-fills</td>
</tr>
<tr>
<td>Typical Built Environment</td>
<td>Single- story family house</td>
</tr>
<tr>
<td>Public Transport (PT)</td>
<td></td>
</tr>
<tr>
<td>City buses</td>
<td>535 (350 operating) on 93 routes</td>
</tr>
<tr>
<td>Minibuses</td>
<td>12,000</td>
</tr>
<tr>
<td>Midibuses</td>
<td>495</td>
</tr>
<tr>
<td>Taxis</td>
<td></td>
</tr>
<tr>
<td>Total PT* trips per year</td>
<td>800,750,000</td>
</tr>
<tr>
<td>PT* trips/person /year</td>
<td>215*</td>
</tr>
<tr>
<td>Car/1,000 inhabitants</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: UITP and UATP (2010), UN-HABITAT (2007), Author

PT* transport service here include both the formal city bus and the informal service provided by privately operating minibuses and the average PT trips/person /year (PTTPY) are calculated/estimated on the basis of this.

There are around 2.25 million PT trips per day in the city of which more 85% are carried out by the informal sector (Table 3.1). Minibuses account for 1.4 million trips/day, midibuses and other taxis 0.55 million trips and city buses 0.3 million trips/day (UITP and UATP, 2010).

### 3.1 Urban Transport Modes and purpose of urban trips

Urban transport modes are broadly classified in to two categories, motorized and non–motorized modes of transport. Walking, cycling and animal drawn/packed fall under the category of non-motorized mode of transport. Motorized urban transport modes include those ranging from individualized motorcycle and vehicles to mass transport systems like buses, trams, trains, metros and ferryboats. The choice of particular mode of transport depends on degree of accessibility of the urban area and availability and quality of the respective modes.

The dispersion of various urban activities at different locations generates urban trips. The purpose of travel from point of origin A to point of destination B encompasses broad range of life activities. These include work trips, school, shopping, recreational and social activities and trips to social services (medical visits and worship center). Work and education are the dominant purposes of urban trips in Addis Ababa (Meron, 2007; Abreha, 2007).
3.1.1 Modal share and transport modes in Addis Ababa

A joint research by International Association of Public Transport (UITP) and African Association of Public Transport (UATP) has given the following modal share for the city of Addis Ababa (Table 3.2). Non-motorized transport, predominantly walking and the collective informal sector (minibuses, taxis) are the dominant means of transport that account for 35 to 40% of urban trips across the whole continent of Africa (UITP and UATP, 2010). The figures are even higher in the case of Addis Ababa. Walking is the predominant mode of transport that accounts for about 60% of urban trips in the city of Addis Ababa (Meron, 2007; Abreha, 2007). However, according to the transport studies by UITP and UATP (2010), walking takes a modal share of only 44% and is followed by minibus (34%). Unlike other cities of Ethiopia, the share of cycling is insignificant in Addis Ababa and is used only in the city center where people bike for recreation in reserved and open urban spaces like Meskel Square and Stadium. Public transport network of the city is at its lowest level with the city bus taking the lowest market share in the provisions of the urban transport service. Despite the high tax on imported vehicles, the car market has picked up its momentum in recent years and its modal share is raised to 9%.

<table>
<thead>
<tr>
<th>Mode of Transport</th>
<th>Modal share</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Bus</td>
<td>7%</td>
</tr>
<tr>
<td>Mini buses</td>
<td>34%</td>
</tr>
<tr>
<td>Walking</td>
<td>44%</td>
</tr>
<tr>
<td>Private taxis</td>
<td>6%</td>
</tr>
<tr>
<td>Private cars</td>
<td>9%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: UITP and UATP (2010)

To date the urban transport service provision in the city of Addis Ababa has been greatly relying on limited number of city buses (535 of which only 325 are operating) (UITP and UATP, 2010) and around 12,000 privately operated blue minibuses (Meron, 2007) and 495 midi buses. The city bus and minibus have carrying capacity of 100 (30 seated and 70 standing) and 12 passengers respectively. Midibuses, which carry 25 passengers, have limited share in the urban transport and operate in the same manner as minibuses-on the basis of full dispatch load.
Urban transport case studies in Addis Ababa show the incompatibility of the traffic composition and the proportion of people transported by respective vehicle types. Cars transport only 15% of people, while accounting for 60% of vehicle traffic. Minibuses take up 23% of all vehicle trips to carry 39% of people, whereas buses carried 45% of people with only 4.5% of the traffic flow (IBIS Transport Consultants Ltd, 2005). This shows that there is an inefficient use of road space by low capacity vehicles. 100 people are carried either by 50 cars, 10 minibuses or just by a single bus.

Source: Kottenhoff, 2012
3.2 Environmental and social Impacts of Transport systems in Addis Ababa–Urban challenges and transport Problems

3.2.1 Urbanization and its impacts-Urban sprawl and land use change

Urbanization which is the net movement of people from rural to urban areas and the natural increase of urban population is the driving force of urban challenges of multiple dimensions. Urban sprawl is a direct consequence of a rapidly urbanizing world which when coupled with lack of long term urban planning intensifies the magnitude of urban problems with regard to the provision of urban infrastructures particularly that of transportation. Since 1950 the world has been urbanizing at a faster rate making the world’s urban population surpass the 50% mark in 2010 (Satterthwaite 2005; Rodrigue, 2009). The increasing proportion of people living in urban areas accelerated the rate of urban sprawl across the globe and in particular in cities of developing countries. Informal settlements and urban sprawl are the direct consequence of rapid urbanization in low income cities (Vestbro, 2010). Located at the strategic and geographical center of Ethiopia, the city of Addis Ababa is the undisputed metropolis of the country and powerhouse of political, economic and social activities. The city has maintained its strong status of being the prime center of employment and urban services which are the compelling reasons for the massive migration of people from the rural and other economically weak urban areas of the country to the capital city. The city is urbanizing at the rate of 4.2% every year (UN-HABITAT, 2010/11) and the rural-urban migration accounts for 40% of the growth (UN-HABITAT, 2008). The ‘pull effect’ of the city results in rapid urbanization that significantly changes the landscape of the city in a short space of time. The built environment of Addis Ababa is dominated by unplanned horizontal expansion of low density detached single- storey house models.

The city of Addis Ababa has been expanding spontaneously and in unplanned fashion. Addis Ababa has experienced and undergone a massive spatial change in the last 50 years. The footprint of Addis Ababa tripled itself from 80km2 in 1960s to 250km2 in 1985 (Demerew, 2009) and doubled to 540km2 in 2010 (Woldu, 2010). The spatial doubling of the city in the last 25 years (1985-2010) is due to massive commercial and real estate developments which are taking place at different corners of the city. The city is still stretching further to the East and West to absorb the ever increasing housing demand and to the South for industrial activities (figure 3-3).
The stretching of the city is inevitable and goes hand in hand with the continuous process of urbanization. The most common typology of the city is a detached single-storey family house within a compound. Replicating of this typology in the new real estate project areas will result in an inefficient use of land space and raises the environmental footprint unless the trend is intercepted and backed up by proper land use planning and densification schemes that promote vertical extensions. This pattern of urban expansion also makes the provision of urban transport infrastructure costly and difficult.

The failure of implementing long-term and strategic land use and public transport plans results in massive envision of greenfields at the expense of prime farmlands. The sprawling metropolitan areas of the city are characterized by pockets of low story housing developments that are isolated from each other and often separated by large open spaces or roads. Introducing a comprehensive long term planning and densification schemes and implementation of these at various appropriate scales is crucial to take control of the fast paced urbanization and the consequent urban sprawl.

### 3.2.2 Congestion, Mobility, Road Accidents

The rising number of urban population coupled with increased usage of low capacity vehicles account for the congested roads and streets of Addis Ababa creating mobility problems to the extent that paralyses the whole traffic on the road. The heavy reliance of urban transport on minibuses and the rise of private automobiles increase the rate of road accidents in the city. Safety is of less priority and concern especially for the
informal transport sector (minibuses) that aggressively compete among each other and the city buses in the quest of profit making. Traffic accident is growing in the city at the rate of 12.5% each year (Meron, 2007) and pedestrians are the most common victims.

3.2.3 Energy consumption and Environmental Impacts
Cities are both the solution providers and problem contributors and are at a close receiving end of impacts of their own activities. Cities consume 75% of world’s energy and contribute for 80% of GHG emissions (Peter et al, 2009). Transport has profound effect on land space and energy consumption and environmental impacts. Sustainable form of urban transportation has a prospect of tackling these growing challenges that arise from heavy reliance on low capacity public transport and individualized vehicle traffic. The city bus carries 9 times more passengers than the minibuses and 25 times more than private cars and consumes 2 times less fuel than the minibuses to transport the same number of passenger per km (UITP and UATP, 2010).

Addis Ababa looks like a ‘smoking city’ when viewed from mount Entoto (the peak of the city with altitude of 3,200m above sea level). This is due to combined effect of tail pipe emission and household fuel combustion. Pilot scale air quality study in Addis Ababa shows that emission of greenhouse gases (GHGs) is pronounced during peak hours of commuting which is associated with motor vehicle traffic (Etyemezian et al, 2005). The environmental impacts like air and noise pollution and GHG emissions as a result of increased travel distance and increased use of land space should be internalized and should be an integral part of the central plan in order to counterbalance the impacts of climate change and increased energy usage which has a lot to do with settlement and transportation patterns that the city is practicing today.

3.2.4 Social Impacts
The ever growing urban population widens the gap between the transport demand and supply. The attempt of providing low capacity vehicles could not and would not solve the problem for the better even with the upgrading and expansion of the road infrastructure; it rather creates further congestion, unpalatable traffic accidents and environmental pollution.

The absence of good public transport reduces the economic productivity of the city and its people’s chance of engaging in social activities. Low quality of public transport, overcrowding at peak hours, long waiting and travel time are the main features of the existing public transport of Addis Ababa. The average waiting time for city buses is 30 minutes (Abreha, 2007) which is an indicator of how low the supply of buses is in the city. About 15% of the scheduled bus trips are also lost every day (IBIS Transport Consultants Ltd. 2005). Average travel time by city bus is 48.5 minutes for average route length of just 13.5km (Abreha, 2007). This makes bus use less attractive
though its fare is comparatively cheaper than that of minibuses. Despite all the inconveniences, the city bus still maintains its primary role of providing transport for low-income people, students and at most for the urban poor which accounts for majority of the city’s inhabitants.

Average walking trip length is 1.5km and the average car trips are 3.3km (Meron, 2007). Addis Ababa is a walking city, partly because it is the only affordable means of transport and partly because the severe shortage of transport leaves people with no practical option but to walk. Accessibility and mobility problems, health problems, loss of public spaces and green areas are other problems that have social implication.

3.3 Transport Infrastructure-Addis Ababa Road Network and Pedestrian facilities

Addis Ababa has 5 major arterial gate roads that radiate from the city center to different parts of the country. The five regional gate roads of the city and other arterial roads are linked to each other by the 8 lanes ring road that circumscribes the city (figure 3-4). The Addis Ababa road network has increased from 2,200km in 2005 (Meron, 2007) to 2,657km in 2010 (Assegid\(^3\), 2010) of which 42.75 % (1,136km) is paved asphalt and the remaining 57.25 % (1,521km) is gravel road. As of 2010, the road network makes up 10% of the total urban built up area of the city (Assegid, 2010). The counterpart figure in western European cities ranges from 15 % to 25% of the urban surface (Rodrigue, 2009).

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Figure 3-4 Addis Ababa City Road Network Map

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\(^3\) Assegid Getachew is Deptuy City Manager of Addis Ababa
### Table 3.3  Addis Ababa road network and pedestrian walkway coverage as of 2010

<table>
<thead>
<tr>
<th>Road Hierarchy</th>
<th>Length of varying width (km)</th>
<th>Length of 7m width (km)</th>
<th>Road condition</th>
<th>Pedestrian walkway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A) Asphalt Roads</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial</td>
<td>344</td>
<td>552</td>
<td>Very good</td>
<td>(Left side (km): 73, Right side (km): 58, Total: 131)</td>
</tr>
<tr>
<td>Sub Arterial</td>
<td>116</td>
<td>167</td>
<td>Very good</td>
<td>(Left side (km): 63, Right side (km): 57, Total: 120)</td>
</tr>
<tr>
<td>Collector</td>
<td>174</td>
<td>209</td>
<td>Good</td>
<td>(Left side (km): 55, Right side (km): 55, Total: 110)</td>
</tr>
<tr>
<td>Local</td>
<td>208</td>
<td>208</td>
<td>Fair</td>
<td>(Left side (km): 13, Right side (km): 13, Total: 26)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1136</strong></td>
<td></td>
<td></td>
<td><strong>387</strong></td>
</tr>
<tr>
<td><strong>B) Gravel Road</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1521</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Network</strong></td>
<td><strong>2657</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Assegid, 2010

The Addis Ababa road network does not have good interconnectivity and extent of coverage. The Office for Revision of Addis Ababa Master Plan (ORAAMP) described the road network as poor quality of design standards, shortage of pedestrian walkways, and badly constrained by misuse and encroachment of road space (Abreha, 2007). It also lacks dedicated service lanes for buses, uninterrupted and safe walkways and cycle paths. Despite high volume of pedestrians in the city, there are no footpaths over greater proportion of the road network (Meron, 2007; Abreha, 2007). As shown in Table 3.3 as of 2010, over 65% ((1136-387)/1136) of the road network is not pedestrianized. This is a major drawback of the existing road network and the newly planned ones. The absence and/or interruption of wide walkways over greater portion of the road network results in spillover of pedestrians into the road. Though waking accounts for greater proportion of urban trips, pedestrians are not the center of attention in the process of road design. On-street parking is also prevalent and this creates congestion and inefficient utilization of the road space. This shows that apart from the inadequacies of the road, the way the different groups use the road (on-street parking, street activities like marketing) affects the performance of the road.

### 3.3.1  Bus network

The bus network of Addis Ababa city is limited in extent and spatial coverage, with the network being more concentrated at the center. Currently it operates on 93 routes radiating from city center with 350 conventional buses dispatched from three main bus terminals. As part of expanding the bus network and its service, Anbessa (Addis Ababa City Bus Enterprise) is on preparation of launching 14 routes operated by articulated buses and a circular route running along the ring road. As per the city bus project, there is a plan of increasing the total fleet of bus to 850 by adding 100
articulated buses and 400 conventional buses (LTPA, 2010). Few articulated buses have recently started operating in the city. Figure 3-5 shows the proposed new network for the articulated buses and circular route.

![Figure 3-5 Proposed network for articulated bus lines and circular route](image)

Source: LTPA (2011)

Residential areas at the outskirts of the city are not well served by the city buses. There are no bus only lanes or bus priority at traffic signals. The inadequacy of the road infrastructure is also reflected in the poor performance of the city bus (long waiting and travel times, walking distance, overcrowding) (Abreha, 2007). The average waiting times of 30 to 45 minutes and average travel time of 48.5 minutes surpass the accepted thresholds of 20 and 30 minutes respectively. These problems arise from the limited deployment of buses (often 3-5 buses per route), poor operational management practices, poorly designed road infrastructure and lack of integrated public transport and built environment planning.

71 % of Addis Ababa residents live in the walking distance range of less than 500m to bus stop, 16 % in the range of 500-1000m and the remaining 13% lives in the range of 1000-2500m (Abreha, 2007). Public transport should be at the center of attention in the planning of new urban areas should walking distance need to be reduced. Compact and mixed use development around public transport networks enhances accessibility to important destinations like working places, universities/schools, medical and shopping centers. Often buses and therefore public transport customers are victims of road congestion. The provision of reserved/dedicated bus lanes in the road space will give buses a competitive advantage to improve important indicators of quality of public transport service (waiting time, travel time).
3.3.2 Pedestrian facilities and Cycle paths

A city with sustainable transport is one which has greater proportion of the most sustainable modes of transport—walking, cycling and public transport. The provision of adequate pedestrian facilities and cycle paths at neighborhood and urban streets is an integral part of sustainable transport planning. The Addis Ababa City Road Authority’s (AACRA) road design manual Section 7 underlines that the boarders of arterial and local streets, among other things, need to include pedestrian footpaths, off-road cycle paths and landscaping (AACRA, 2003:7:p.23). And in particular, on the provision of cycle paths, Section 5.5 of AACRA’s design manual states that:

“Cycling is not very popular in Addis Ababa. However, changes in socio-economic characteristics may result in provision of cyclists becoming increasingly important in the future. Consideration should be given to including spatial provision in the new road reserves for future bicycle facilities” (AACRA, 2003:5.5:p28).

However, the mismatch between design and planning guidelines and operational practices is reflected in the design of arterial roads like the newly started Bole road which lacks reserved cycle paths for future use and wide walkways/boulevards that can accommodate the greater proportion of pedestrians in the city. While Western cities are pedestrianizing their old streets and urban cores and expanding their cycle networks, developing cities on the other hand, are deteriorating these important modes (Newman and Kenworthy, 1999). In developing cities, walking and cycling are perceived as obsolete modes of transport (Newman and Kenworthy, 1999) and are being gradually replaced by motorized transport—the car which is seen as symbol of status, prestige, and success (Rodrigue, 2009).

Addis Ababa is a walking city, with walking accounting for 50 to 60% of the urban trips. Though this is the case, as described in section 3.3 and Table 3.3 more than 65% the road network is not pedestrianized indicating that there is a clear policy neglect of non-motorized modes in the design of road infrastructure. In developing cities like Addis Ababa, the primary focus of road design is moving cars from A to B and this result in widening of the road space or building of new highways/interchanges that are exclusively designed for cars. Automobile-oriented environments are neither safe nor convenient for the non-motorized modes of transport and usually pedestrians and cyclists are victims of accidents in such typical urban environments. Cities that are developing walking and cycling infrastructures learn quickly that these modes are more compatible with public transport than with auto city infrastructures (Newman and Kenworthy, 1999). Promoting transit oriented development (TOD) and complete street design is a key for preserving the most sustainable and green modes of transport—walking and cycling.
### 3.4 Institutional Frameworks and Actors in the Planning Arena

Addis Ababa Transport Authority (AATA) and Addis Ababa City Road Authority (AACRA) come under the umbrella of Addis Ababa Municipality service. The former is responsible for public and private transport service in the city. AACRA is responsible for the design and maintenance of roads. The city bus is run by a state-owned and sole organization called Anbessa City Bus Service Enterprise which is responsible for both public transport service design and operation. It will also be in charge of running the BRT and AA-LRT/light rail transport service once its construction work is finalized. The city bus is run and subsidized by the city council.

![Institutional Organization](image)

The cooperation, understanding and meaningful participation of the various actors (AACRA, AATA, private operators (minibuses), Addis Ababa City Bus Enterprise, and the Ethiopian Railway Corporation (ERC) in the planning arena is instrumental for effective implementation of transport policies and proper functioning of urban transport service. Planning as a process also requires public participation at large for appropriate design and effective implementation of transport policies/plans.

### 3.5 Contemporary practices and future transport plans of the City

**AA-LRT, BRT and Bole road projects**

Addis Ababa accounts for more than 25% of the urban population of the country. It is a city of around 5 million inhabitants and according to UN estimate and expert’s prediction, the population of the capital city will rise to 8 million by the year 2025 (Herbel, 2009). The question ‘What type of transport infrastructure and urban developments are practiced in the city of Addis Ababa and how compatible these practices are to the current and future challenges of the city?’ is one of the driving questions of that make up this research. Street-liners and in-fills are the two main elements that make up the basic urban tissues of Addis Ababa (Baumeister and Kneble, 2009). A linear development of mid-high rise commercial and office buildings along the expanding main streets of the city and single-storey residential buildings in-between the grid of the street network make the basic urban structure of the city. The 2002 Revised Master Plan of Addis Ababa demands that buildings along the streets of the city need to conform to the minimum requirement of G+5. This plan preserves and reinforces the street-liners and in-fills which give the basic character of the city.
The extent, quality and pattern of transport infrastructure and service dictate development and affects the socio-economic activities and people’s preferences of living and working places.

The city has been expanding more than ever horizontally into its outskirts. A wide range of real estate developments and commercial activities are being taking place at different corners of the city. Road networks and expansions have been undertaking and new ones are launched as integral parts of the five year development plan. The recently started 5km Bole road project is one of the long awaited and a high profile project amounting 60 million US dollars. Spontaneous developments both in the inner and outskirts of the city are accelerating the rate of urban sprawl. Isolated new high rises are popping up along the new and old streets of the city. Setting a framework for a city of this size has become the defining question of the time and probably the upcoming LRT and BRT corridors could serve as a backbone around which the city’s future development can begin to take a form in a planned fashion. However, putting master plans into practice at city scale is a very challenging task if the key actors (public authorities, urban planners, architects, potential developers and companies) operate separately and keep on engaging in planning and development practices that are not integrated in to each other. Often local urban planning and development practices prevail over master plans. And as a consequence, such uncoordinated practices create incompatibility for long term PT networks and may raise land acquisition issues if rights of way are not preserved from the outset.

The Revised Master Plan (2002) (figure 3-7) and the Transportation Master Plan of Addis Ababa city (2005) (figure 3-8) were designed with the purpose of coordinating the city’s current and future urban development and mass transportation systems (Lyon Town Planning Agency\(^4\), 2010). As shown in figure 3-7, the Structural Plan is based on the two major transportation corridors of the city (East-West and North-South) development axis (blue) linking strategic development areas (red) and current and future expansion areas (yellow). However, management problems, uncoordinated local planning practices, financial constraints of mass transit programs (LRT and BRT projects) and land acquisition issues have been challenging the successful and timely implementation of the transport and the revised master plans of the city as per design.

\(^4\) Lyon Town Planning Agency (LTPA) has been engaged in the feasibility study, design, management support and revision of master plan of the Addis Ababa LRT and BRT projects under the framework of the Ethio-French 2002-2010 bilateral government cooperation.
A number of highway projects and mass transport plans are unveiled in the same space of time since 2010. In response to the growing urban transportation problems of the city, the city Transport Authority (AATA) has unveiled the first bus rapid transit (BRT) pilot project which is expected to be introduced to the metropolis at the beginning of the third quarter of 2012 (Addis Ababa Online, 2012). The Ethiopian Railway Corporation (ERC) has also launched the Addis Ababa light rail transit (AA-LRT) project in September 2011 (ERC, 2011). The BRT and LRT projects are launched as integral package of the declared five-year Growth and Transformation Plan (GTP). The AA- LRT project whose construction has been kicked off at the beginning of 2012 falls under the medium term public transport (PT) planning. According to the heralded news and transport authorities, the first phase of the project is expected to be completed in 2 and have years time (Addis Ababa Online, 2012). The T-shaped LRT line runs through the two major transportation corridors of the city; the East-West axis (17.35km) and North-South axis (16.9km) covering a total distance of 34.25km.
The AA-LRT has a capacity of 60,000 to 80,000 passengers per hour (PPH) in four directions (Addis Ababa Online, 2012; ERC, 2011). A light train/modern tram has thus a patronage level of 15,000 to 20,000 passengers per hour and direction. A 15m wide space is reserved for LRT tracks in the middle of the two transport axes and construction has commenced at two places. The new BRT and LRT projects, apart from bridging the gap between the transport supply and demand of the capital city, have a high prospect of guiding the city’s urban development. The LRT lines run through the 2 main transportation corridors of the city and thus can serve as a framework to shape the urban planning around the transit spines.

A brief description of the new highway and BRT proposal for Bole road is treated separately as case study in chapter 5.
4 Methodology

4.1 Methodological Approach

The paper entails a case-based exploratory research approach to study public transport networks and built environment. It tries to explore urban transport challenges and how the practice of TOD as planning guideline helps to integrate public transport networks and urban planning towards the creation of livable and accessible urban environments. The concepts of TOD and accessibility, which have been thoroughly discussed in the literature review, form the conceptual framework on which the methodological approach of this research is based. Accessibility, complete streets, placemaking and PT performance measures are identified as key indicators of integrated transport and urban planning. These concepts are then operationalized through the investigation of practical case studies to test and further develop the research methodology. The case of LRT-based TOD neighborhood of Stockholm is taken as representative of best practice of integrated transport and urban planning.

The problem of prioritizing auto-oriented city structures is prevalent in many of US cities and is gradually expressing itself in developing cities like Addis Ababa. This pattern of urban development is changing the cityscape and the consequent social and environmental impacts are addressed from the perspective of sustainable accessibility. Thus, as part of research methodology, this paper tries to explore experiences of integrated LRT transportation corridors and transect of complete streets at city and neighborhood scale. The concern of accessibility, mobility and the need for improving the quality of public transport networks and service provision in the city of Addis Ababa is an integral part of the thesis.

4.2 Case study as research strategy

A case-based research approach is used in this thesis to study the relation between public transport networks and built environment. Like any other research methodology cases have their own pros and cons. Case studies are interesting as they are contextually rich and show the different ways of handling a certain urban problem in places of different contextual settings. Cases are good demonstrations of good/bad practices and provide wide pool of knowledge and hence server as a source of inspiration for practicing professionals of diverse disciplines—urban planners, engineers, policy makers or public authority officials. Politicians and general public think in terms of cases and like to know the experiences of how other places managed a certain urban phenomenon (Cervero, 1998:22). On the
other hand, drawing of conclusions from cases without weighing the contextual relevance and economic viability of cities could also lead to misleading interpretation. The study of urban transportation patterns on the basis of cases provides valuable lessons worth learning from proven experiences and potential alternatives to successfully integrate public transport and the physical expansion of urban areas across space and time. Cases are also suitable for comparison purposes.

The impacts of Bole road on accessibility, mobility and placemaking and its compliance to complete street design are researched in this thesis. These particular case studies are evaluated based on the conceptual framework developed from literature review. Qualitative analysis of the two case studies is performed on the basis of the information gathered from field observation, books, scientific articles and various sources from internet.

Table 4.1 Research Matrix

<table>
<thead>
<tr>
<th>Specific Research objectives</th>
<th>Methodology</th>
<th>Cases studies</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying transport problems and urban challenges of Addis Ababa</td>
<td>Case studies</td>
<td>AA-LRT and Bole road projects</td>
<td>Primary and secondary sources Internet</td>
</tr>
<tr>
<td>Defining indicators of integrated public transport and built environment</td>
<td>Literature review, Case studies, Building theoretical framework</td>
<td>LRT–Based TOD of Stockholm</td>
<td>Primary and secondary sources (books, scientific articles, Internet) Field observation</td>
</tr>
<tr>
<td>Improving transport infrastructure planning practice</td>
<td>Literature review</td>
<td>Bole road</td>
<td>Primary and secondary sources, AACRA design manuals/documents</td>
</tr>
</tbody>
</table>

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5 Case Studies
The case of Addis Ababa’s Bole road and the LRT- based TOD corridor/neighborhood of Stockholm will be explored in the consequent sections. These practical case studies will be evaluated on the basis of the indicators identified in literature review and the concepts established in the theoretical framework and are expected to complement the research methodology.

5.1 Addis Ababa – The case of Bole road

5.1.1 The BRT plan for Bole road
A long term PT network that consists of 2 LRT lines, 7 BRT corridors and 3 efficient bus lines is designed for the city of Addis Ababa. Detail design and feasibility study of the BRT network has been undertaken by Lyon Town Planning Agency (LTPA) since 2005 and the proposals of city’s BRT corridors were presented in October 2010. Of the 7 proposed BRT lines constitutes the Bole road which is labeled as BRT corridor B6 (Pink line) running from Bole Airport to Leghare as shown in figure 5-1. The pink line (B6) radiates from the city center and meets the proposed circular BRT corridor at the ring road near Bole Airport. LTPA (2010) ranked the B6 corridor as the 2nd most important corridor that can be implemented next to the B2 corridor (Gofa Gabriel–Mexico–Merkato–Wingate). The ranking of BRT corridors is based on the multicriteria analysis that considers ridership, long term PT network, autonomy, easy implementation, type of people served, impact on traffic, and existing city /developing areas.

Figure 5-1 Map of long term Public transport network of Addis Ababa-BRT and LRT network

Source: LTPA (2010)
The Bole road is the shortest route to the city center and connects important regional destinations. It links Bole International Airport to Meskel square (the largest public space of the city), national football stadium, CBDs and bus terminal at Leghare. The analysis of the proposed BRT corridor B6 along Bole road shows that the Bole Airport-Leghare route is expected to have high ridership and is connected to both LRT lines at Leghare making it fully compatible to the long term PT network (LTPA, 2010). B6 complements the circular BRT corridor and the two LRT lines by enabling short and direct access to the city center. It also serves the central area at Legahare bus terminal and can also be extended to Mexico to meet B2 and therefore, will be a very efficient corridor even before the construction of LRT line (LTPA, 2010). However, this particular route has implementation difficulty due to high traffic along the route, type of people served (middle-high income group) and topographical layout of the road (LTPA, 2010). Bole road is fairly flat except for a shorter stretch where it crosses a river just before reaching the junction at Wollo Sefer and therefore, the last argument is questionable as it can reasonably be solved by technical solution. Addis is a city where peoples of different income groups live together. And except at one end of the road near Bole Airport area, majority of the in-fills along this corridor (Flamingo, Olympia, Wollo Sefer) are predominantly residences of low to middle income groups.

5.1.2 Bole road in practice and the new motorway

As part of upgrading the road network of the city, the Addis Ababa City Roads Authority (AACRA) unveiled the start of the 40m wide and 5km long Bole road in January 2012. The Bole road stretches from Meskel Square to Bole International Airport and is the only international gate to the city and one of the heavily congested arterial roads of the city. The 30m wide old Bole road is to be replaced with new 40m wide road having 8 lanes and 3 overpass interchanges at Olympia, Wollo Sefer and Ruanda junctions as shown in the figure 5-2.
Figure 5-2 The look of the new Bole road and its junctions at Olympia, Wollo Sefer and Ruanda

Figure 5-3 Apartments and mixed use buildings along Bole road
A wide range of destinations (5 shopping centers, school and college, medical center, a number financial institutions, mid (4-5 storey) and high-rise residential apartments (10-12 storey) and 8-12 storey commercial and office buildings line up along the bole road making it suitable for transit supportive development (figure 5-3). The Bole road enjoys broad spectrum of public services, working and living places in as stretch of less than 5 km and has relatively shorter and good accessibility to the city center. It has more street-liners than any other arterial roads of the city. Given these attributes of mixed land use, the recently started Bole road, however, lacks diversity in terms of providing multimodal transport system that comprises reserved bus lanes or LRT/BRT lines, wide pedestrian walkways and cycle paths. Despite the staggering number of pedestrians in the city, more than 65% of the road network is not pedestrianized and the newly constructed or planned roads like Bole roads are far from being pedestrianized streets/roads. Dirk Hebel5 (2009) highlights that Addis Ababa is implementing highway projects in a similar fashion as that of the 1950s US and is following the footsteps of an individualized transports system and beliefs of a motorized society. The road planning and design practice has to shift from the conventional way of planning of roads and highways for cars to multimodal and PT-oriented planning in order to overcome the viscous circle of congestion.

5.2 The case of Stockholm -LRT- based TOD: Tvärbanan-LRT corridor

5.2.1 Introduction

Stockholm is known as a world-class transit metropolis. In 2009, more than 75 % or 3 out of 4 Stockholmers travelled by public transport during peak hours (SL, 2010). This is rather a remarkable figure as Stockholm is a city of affluent country which has one of the highest car ownership rate (500 per 1,000 inhabitants). The high PT ridership contributed to significant social and environmental benefits and played its own share for the reward of Stockholm as Green Capital of Europe in 2010. The experience of Stockholm shows the benefits of coordinating urban development and rail transit services within the framework of regional planning (Cervero, 1998). The Stockholm Metro which was built in 1950s guides the development of the city and it is the backbone for the present form of the city. The polycentric urban centers are configured in a star-shaped pattern around rail corridors radiating from the city center. It is the building of the compact urban cores around well serving rail corridors that account for the higher transit ridership and transport efficiency in the city of Stockholm. The concentration of living and working areas around a rail served urban cores and

5Dirk Hebel is a German architect and urban planner and has been the Scientific Director of Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) for 5 years since 2006. He is co-founder of Urban Laboratory-Addis Ababa-a research initiative lunched by Zurich Institute of Technology (ETHZ) and Addis Ababa University (AAU).
suburban corridors result in a transit-land use nexus which helped Stockholm to enjoy a balanced bidirectional ridership with directional split of 45:55 during peak commuting hours (Cervero, 1998).

Table 5.1 Stockholm City profile and Public Transport

<table>
<thead>
<tr>
<th>City profile and Public Transport/ PT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhabitants</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>864,324 (2011)</td>
</tr>
<tr>
<td>Metropolitan area</td>
<td>2,091,473 (2011)</td>
</tr>
<tr>
<td>City</td>
<td>187 km2</td>
</tr>
<tr>
<td>Metropolitan area</td>
<td>6,526 km2 (2012)</td>
</tr>
<tr>
<td>Density</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>4,200 inh/km2</td>
</tr>
<tr>
<td>Metropolitan area</td>
<td>296 inh/km2</td>
</tr>
<tr>
<td>Metro lines (T)</td>
<td>3 bundle with 7 total lines on 110 km, 105 stations</td>
</tr>
<tr>
<td>Commuter trains (J)</td>
<td>5 on 295 km</td>
</tr>
<tr>
<td>Tramways (LRT)</td>
<td>5 on 30 km</td>
</tr>
<tr>
<td>Buses</td>
<td>4 lines of Blue buses, and 500 routes of city buses</td>
</tr>
<tr>
<td>Bike-sharing system</td>
<td>94 stations, 750 km cycle path</td>
</tr>
<tr>
<td>Public Transport (PT)</td>
<td></td>
</tr>
<tr>
<td>Total PT trips per year</td>
<td>585,000,000</td>
</tr>
<tr>
<td>PT trips/person/year</td>
<td>350</td>
</tr>
<tr>
<td>Car/1,000 inhabitants</td>
<td>500</td>
</tr>
</tbody>
</table>

Source: skyscraperCity (2011)

Stockholm has a well-integrated public transport system consisting of three hierarchies of PT network that is crowned by the metro. The metro is the backbone of the PT network to which the commuter trains, trams and buses serve as feeders. The green, blue and red metro lines link urban cores and suburban satellites to enable urban and regional accessibility. The articulated blue buses operating on 4 distinctive lines play a complementing role to the metro by connecting suburbs to the central urban areas. The commuter trains serve suburban areas and take workers to and from the city. And the conventional red buses and trams circulate the city and serve both the urban and suburban areas at local level.

The increase in population and transit ridership creates congestion problem at central Stockholm and Gamla Stan (Old Town) bottleneck through which a number of metros, commuter trains and intercity trains pass. The need for relieving the congestion problem during peak hours at Gamla Stan bottleneck gave rise to the opening of the Stockholm Tvärbanan or crossway line that allowed passengers to bypass the city center and thus save time (Hade, 2010). A tramway locally named as Tvärbanan is an orbital light rail transit (LRT) corridor in the city of Stockholm. The light rail line was partially opened for traffic in 2000 with the purpose of connecting the southern and western parts of Stockholm without having to pass through the city center. The 11.5kms line stretching from Alvik to Sickla Udde was fully completed in 2002 and provides service for more than 50,000 passengers per weekday (City of Stockholm,
The tram line connects four major interchange transit stations from which passengers can access wide range of PT modes (trams, commuter trains, metros and buses) to go to different parts of the city.

A combination of segregated right of way (ROW) and mixed/integrated infrastructure is used for the LRT (figure 5-4). At Liljeholmen, modern trams/light rail vehicles (LRV), buses and cars share the same road space as the LRT infrastructure is integrated with the road. The tram has a reserved ROW in Hammarby Sjöstad and in most parts of the line. The adaptability of the LRT infrastructure to the surrounding environment is one of the competitive advantages of LRT.

![Figure 5-4 LRV on mixed infrastructure at Liljholmen (left) and segregated infrastructure (right)](image)

**5.2.2 Hammarby Sjöstad-LRT-based TOD neighborhood in Stockholm**

The LRT corridor paved the way for brownfield development of the Hammarby Sjöstad (waterfront city) that is acknowledged as an attractive TOD neighborhood in the southern part of Stockholm. The neighborhood is located at a distance of 3km from the city center. Hammarby Sjöstad stands as Stockholm’s largest urban regeneration project in repose to the Stockholm’s 1999 City Plan that set a vision of ‘Building the City Inwards’ (Cervero and Sullivan, 2011). The project in this area has enabled to realize the vision of reducing greenfield development by building new towns in brownfields.
This place is a showcase where urban planning and public transport are integrated using the principles of TOD. The transit oriented development (TOD) in this place is characterized by dense clustering of high-rise (6-8) storey commercial and residential buildings with walking distance to tram stations. The building heights taper with distance from the LRT spine. The road is designed to accommodate multiple modes: trams, buses, cyclists, pedestrians and car users (figure 5-5). The mixed land use development around the transit spine enabled to bring destinations closer and this makes walking/cycling and PT use more entertaining than using the car.
As shown in the *figure 5-5 & 5-6*, trams run through the center of the LRT based-TOD at Hammarby Sjöstad and tram stations are well designed and fully weather protected and provides real-time arrival information. The 37.5m wide transit corridor is divided into tram/bus way, green corridors, car lane, cycle paths, parking space, and pedestrian walkways. Trams and buses run on a shared lane of 15.5m wide at the center of the street which includes a pair of green corridors and street trees. The neighborhood has parks, attractive public spaces, playing grounds, and four tram stations with a spacing of 500m. The interconnected networks of neighborhood streets intersect with the transit spine every block and are within walking distance range to transit stations. The grid pattern network of streets encourages walking and makes destination accessibility easier. Table 5.2 shows the features of built environment, infrastructure, and respective policies/programs taken to integrate transport and urban planning in the area. The dense and divers pattern of development with central transit corridor coupled with car and bike sharing services have enabled to reduce the project’s VKT and shrink the environmental footprints of the residents by 1/3 compared to other suburban neighborhoods in Stockholm (Cervero and Sullian, 2011).
Table 5.2 TOD attributes of Hammarby Sjöstad

<table>
<thead>
<tr>
<th>Built environment</th>
<th>Infrastructure</th>
<th>Programmes and Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfield</td>
<td>Tvärbanan light rail line: four stops in district</td>
<td>• Transit-boulevard is focus of activity/commerce</td>
</tr>
<tr>
<td>• Infill</td>
<td>◦ 5 min to major station</td>
<td>• Grid streets increase connectivity/calm traffic</td>
</tr>
<tr>
<td>• Former army barracks</td>
<td>◦ 10–30 min to all parts of city center</td>
<td>• Convenient bike parking/storage at every building</td>
</tr>
<tr>
<td>• High density along light-rail boulevard (eight stories)</td>
<td>◦ 7 min peak headway</td>
<td>• Car-sharing:</td>
</tr>
<tr>
<td>• TOD: mixed use with ground-floor retail: wide range of goods and services</td>
<td>◦ Two bus lines</td>
<td>3 companies, 37 vehicles</td>
</tr>
<tr>
<td></td>
<td>◦ Ferry service</td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Bike lanes and bike and pedestrian bridges: ample bike parking at every building</td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Near congestion toll boundary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>◦ Pedestrian-friendly design/complete streets</td>
<td></td>
</tr>
</tbody>
</table>

Source: Cervero and Sullian,(2011)

This is place where walking, cycling and PT are the preferred mode of transport with PT taking the greater share. In comparison to the inner city and other suburbs, Hammarby Sjöstad enjoys more PT ridership with modal share of 57%, walking and cycling 27% and private car 21% in 2002 (Brick 2008; Cervero and Sullian, 2011) (Table 5.3).

Table 5.3 Mode splits for journeys with destination in Stockholm County

<table>
<thead>
<tr>
<th></th>
<th>Inner city %</th>
<th>Southern Suburbs %</th>
<th>Western Suburbs %</th>
<th>Hammarby Sjöstad %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>17</td>
<td>39</td>
<td>43</td>
<td>21</td>
</tr>
<tr>
<td>Public Transport [PT]</td>
<td>36</td>
<td>28</td>
<td>23</td>
<td>57</td>
</tr>
<tr>
<td>Bike/walk</td>
<td>47</td>
<td>32</td>
<td>34</td>
<td>27</td>
</tr>
</tbody>
</table>

Source: Brick (2008); Cervero and Sullian, (2011)

Trams account for 34% of modal share of PT whereas the two bus lines serving the area take up the remaining portion of the PT share (18%) (Brick, 2008). The green modes account for 27% of which 18% is taken up by walking and the rest (9%) by biking. The introduction of light rail line reduced the modal share of car from 35% to
21% and improvement of the neighborhood streets in to pedestrian-friendly and interconnected streets mark up the modal share of walking from 8% to 18%. The figures in Table 5.3 will have high probability of exceeding from that of the 2002 values as development practice that are in line with the goal of making Stockholm a fossil-free city in 2050 are undertaking. Hammarby Sjösta is located just outside the Stockholm congestion charging area and this contribute to the rise of ridership (Foletta, 2010) as shown in the figure 5-7.

![Figure 5-7 Ridership on Tvärbanan (LRT) line](Source: Felotta (2010))

The undergoing expansion projects which are taking place at both ends of the LRT line will improve cross-city connection to the underground metro lines up in the north to Solna (a suburb on metro line and the future site of national football stadium) and Kista (a regional node and center of technopolis) and in the south to commuter trains that serve the southeastern Stockholm. The extension and expansion projects will be accompanied with construction of residential and work places which when completed in 2017 will increase the ridership to more than 150,000 passengers per weekday (City of Stockholm, 2012).

In summary, TOD can be used as an effective planning instrument to integrate public transport and urban planning practice towards the objectives of creating vibrant city life and reduced environmental footprint. Cities are about places and people and TOD can offer that and its practice will be rewarding as it is a hardware of sustainable urban regions. PT supportive cities and suburbs are characterized by compact, mixed use and pedestrian friendly urban environments. PT networks make the heart of TOD and TOD has the capacity of improving the performance of PT by designing the built environment to best fit the demand of PT by maximizing accessibility and reducing car-based mobility.
6 Findings and Analysis of case studies

The new Bole road is designed in similar fashion as that of the ring road and it is expected to have almost the same effect to the surrounding built environment and human activities. The 8 lane Bole road has many disadvantages when evaluated from the perspective of accessibility, complete street design, placemaking and its potential of being a sustainable urban corridor (Table 6.1). Though the road is being built under the expectation relieving the excessive congestion in the particular corridor, in the long run it will induce more car use and hence congestion. Public transport is an effective instrument for tackling the viscous circle of congestion. In many European countries, congestion is one of the main political reasons for expanding public transport (Kottenhoff, 2012).

The rapid urbanization in developing cities like Addis Ababa makes the argument for public transport even more urgent. As shown in alternative 2 and briefly explained in the case study of Bole road, the proposed BRT corridor (Bole Airport-Leghare) provide quick access to important city destinations and is highly compatible to the future LRT and BRT network making it a very efficient and sustainable urban corridor. This opportunity, however, is reduced or lost in favor of the motorway. The 5km highway is not also justifiable in economic terms as the BRT can be constructed in the same range of cost or even for half of the cost of highway depending on design specification and road perimeter (Table 6.1).
Table 6.1 Comparison of Alternatives for Bole road

<table>
<thead>
<tr>
<th>Alternative 1-Motorway</th>
<th>Alternative 2- Transit corridor (BRT/LRT-based TOD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>Shorter travel time</td>
<td>Induces urban barrier effect (overpasses and lane walls)</td>
</tr>
<tr>
<td>Reduces congestion (at intersections) for short term</td>
<td>Increases congestion in the long run/induce car use</td>
</tr>
<tr>
<td>Less expensive* ($60 million)</td>
<td>Urban fragmentation (like the ring road)</td>
</tr>
<tr>
<td></td>
<td>Reduces pedestrian accessibility</td>
</tr>
<tr>
<td></td>
<td>Reduces the attractiveness of the place</td>
</tr>
<tr>
<td></td>
<td>Not pedestrian and environmentally friendly</td>
</tr>
<tr>
<td></td>
<td>Inefficient use of land space (40m wide, car focused)</td>
</tr>
<tr>
<td></td>
<td>Loss of green strips</td>
</tr>
</tbody>
</table>

| **Advantages**          | **Disadvantages**                                |
| Increases accessibility and ridership | Longer travel time                                |
| Reduces congestion          | Partially impermeable barriers                    |
| Pedestrian and environmentally friendly | Needs coordination to reduce impact on traffic |
| Good for placemaking/public space/landscaping | More expensive *($75-125 million) estimated for LRT |
| Enhances compact development/activity diversity |                                                      |
| Space efficient, Complete street design |                                                      |
| Very compatible to the future PT network |                                                      |
| *Half or as expensive as motorway if BRT is selected ($25-75 million) estimated* |                                                      |

*The global cost of LRT ranges from $15 to 40 million per km including the vehicles cost. The newly started East - West LRT line costs $15M/km. The estimated cost of a 5km LRT line with optimum unit cost of $15-25M/km would be $75-125 million. The global cost for BRT without including the rolling stock is $5 million/km for trolley bus and $2 million/km for diesel bus (LTPA, 2010). However, the estimated cost of the 1st ranked BRT corridor of the city, B2 is $3.5 million/km including the rolling stock (LTPA, 2010). A unit cost $5-15M/km would give an estimated cost of $25-75 million for the 5km Bole road with BRT corridor.*

Bole road hosts broad spectrum of destinations in a stretch of just less than 5 km and provides good connectivity to the city center, key transport nodes and public spaces (Meskel Square). Along this corridor lies three places of high activity concentrations at zone/district 1 (Bole), district 4 (Olympia) and district 5 (Flamingo) that may face urban fragmentation due to barrier effect imposed by the new motorway infrastructures (*figure 6-1*). The interchanges/underpasses, crossway bridges and lane dividing concrete walls impose barrier effect and induce accessibility problems for pedestrians though they look good from safety point of view and quick traffic flow (*figure 6-3*). The calming effect of the node will also be reduced at the three junctions as the traffic swifts quickly though the underpasses. This enables to reduce congestion at the nodes and saves time for motorists though it diminishes the role of the nodes from placemaking point of view as they are important focal points of gathering.
Figure 6-1 Bole road with BRT/LRT based TOD
Figure 6-2 Hammarby Sjöstad LRT- based TOD Neighborhood
Figure 6-3 New Bole road barrier effects at three major junctions

Figure 6-4 Neighborhood street pattern and accessibility at selected places along Bole road
Table 6.2 Summary of Findings

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Bole road-Motorway</th>
<th>Bole road-(BRT/LRT)</th>
<th>Hammarby Sjöstad-LRT TOD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accessibility</strong></td>
<td>Good, (diverse destinations 600-715m (7 bus stops) affects pedestrian accessibility)</td>
<td>Very good (diverse destinations and services 500-550m (10 stops))</td>
<td>Very good (diverse destinations and services 500m (4 stops))</td>
</tr>
<tr>
<td><strong>Complete street</strong></td>
<td>Incomplete width of street 40m wide with 8 traffic lanes (80% road space allocated for cars), pedestrian unfriendly and no bus only lanes</td>
<td>complete width of street 30-40m with acceptable proportion of modes</td>
<td>Fully complete (all modes are represented and have balanced share of space) 37.5m wide Transit-boulevards</td>
</tr>
<tr>
<td><strong>Placemaking</strong></td>
<td>Barrier effect, creates bad image/unattractive and uncomfortable for pedestrians/street as a road /throwaway</td>
<td>BRT/LRT to introduce good image and attractive longitudinal corridor that is comfortable and safe for pedestrians</td>
<td>Attractive LRT corridor with green strips, focal public spaces-street as a space</td>
</tr>
<tr>
<td><strong>Compatibility/integrity to PT network</strong></td>
<td>Poor, (car-focused design)</td>
<td>Very good an highly efficient (ranked as 2nd best BRT corridor)</td>
<td>Very good (Connected to 4 Metro stations and can be improved with extensions)</td>
</tr>
<tr>
<td><strong>Built environment</strong></td>
<td>Fairly compact and mixed use street-liners (8-12 storey), bounded by in-fills</td>
<td>Compact and mixed use street-liners (8-12 storey) a prospect for TOD</td>
<td>Linearly compact and mixed use TOD (6-8 storey)</td>
</tr>
<tr>
<td><strong>Street pattern (within 500m radius)</strong></td>
<td>Partially irregular</td>
<td>Partially irregular</td>
<td>Grid pattern, walkable and interconnected streets,</td>
</tr>
<tr>
<td><strong>Distance to city center</strong></td>
<td>1-5km</td>
<td>1-5km</td>
<td>3km</td>
</tr>
</tbody>
</table>

The urban context and use of road space varies in the two case studies. However, both case studies have similarities in their distance to city center (3-5km), composition of services (land use mixes) and integrity to PT network and hence provide good access to important destinations within and out of the neighborhood. Hammarby Sjöstad has a grid pattern and interconnected network of streets (figure 5-5 and 6-2). This enhances accessibility of the area and calms the traffic coming from adjacent areas to the transit spine. On the other hand, neighborhoods/districts along the Bole road have irregular street patterns which have less connectivity to each other and to the arterial road (figure 6-4). The 37.5m wide transit corridor is proportionally distributed to all modes with public transport (trams and buses) taking the highest share of space 15.5m (40%), cars 12m (30%) and pedestrians and cyclists 10m (30%). In the case of Bole road,
however, the 40m wide street of 8 lanes is entirely dedicated to car traffic (80%) and pedestrians take only 15% of the road space.

One of the criteria for the selection/ranking of the 7 BRT corridors is the easiness of implementation (i.e. without widening the existing street/land acquisition processes). And the 30 m wide old Bole road responds well in to this criterion. If the BRT proposal was approved, the road space could have been proportioned in to 3.5m wide BRT lanes in each direction, 2.5m wide green strip/tree planter at the center, and 6.5m wide road space for private vehicles and 3.25m wide pedestrian walkway on either side of the street (figure 6-5). The station platforms are 3.5wide each and the BRT platforms are separated from the rest of the road by 0.25m wide curbstones on either side of the BRT lanes/platforms. The placing of the bus lanes at the center would enable to plant trees at places where there no stops and protects interruptions of the buses at intersections.

![Figure 6-5 Cross section of 30 m wide road space with BRT corridor](source: LTPA (2010))

The above arrangement will give a high share of space for cars (more than 40%), public transport (30%) and pedestrians (20%). This allocation of the street space is acceptable for the Bole road since it has high volume of traffic. The widening of the street from 30 to 40m, however, would enable to strike modal balance and give more space for pedestrians and/or reserved cycle paths. In this case, the probable option would be to dedicate three care lanes in each direction (45%) and distribute the remaining road space proportionally to public transport (30%), pedestrian and/or cycle paths (25%).

In summary, both Bole road and the LRT-based neighborhood of Stockholm are important urban corridors that offer broad range of destinations/services, good connectivity to city center and to PT network. The finding of research shows that the current urban development practice and road infrastructure like Bole road are not compatible to the future challenges and long term PT plans. The general findings of the research also show that the provision of adequate pedestrian facilities, cycle paths and bus lanes is given less priority in existing road network of Addis Ababa and in the
design of new transport infrastructure. Bole road is ranked $2^{nd}$ on the BRT implementation priority by LTPA and has high prospect of being a sustainable urban corridor. However, the new Bole road is designed as a raceway for motorists and this will substantially compromise the accessibility of destinations, values of placemaking, public transport and the design of complete and pedestrian friendly streets. The prioritization of public transport, and pedestrians friendly urban environments through TOD and complete street design are the important lessons from the case study of Stockholm.
7 Discussion, Concluding remarks and Recommendations

A summary of research methodology, findings and answers to research questions is presented in relation to the knowledge extracted form literature review and the conceptual framework developed from literatures and case studies. The research followed the process of identification of real world problem, formulation of theoretical framework and explored cases as methodological approach. A case-based descriptive research approach is interesting to compare the different ways of handling a certain urban phenomena. Cases are also contextually rich and provide wide pool of knowledge. However, the method and therefore the findings of the research can be improved with the adoption of other alternative methods like interviews and/or questionnaires. This would enable to reflect the views of the different stakeholders of the urban issue in concern. In the context of Addis Ababa, the case study is also limited to the specific case of Bole road. A more complete picture at urban and regional level can be found if the effect and interaction of the major transportation corridors of the city, the ring road, and the regional arterial roads are taken in to account.

The city of Addis Ababa is practicing both the trend of motorization as reflected in the case of Bole road and the medium and long term PT networks of the LRT and BRT corridors. The 40 m wide new bole road is not designed in a compatible manner to the long-term PT network and to the objective of providing accessible transport modes for all groups of road users in acceptable and sustainable way. The findings of case studies show the contrasting ways of designing urban corridor-conventional (car- based mobility) and transit and accessibility-based transport planning. The case of Bole road and LRT-based TOD neighborhood are practical examples of the contrasting approaches of transport infrastructure planning. The comparison of the two approaches and city types (Table 2.1& 2.3) and result of case studies (Table 6.1 & 6.2) show that in the former case, car is the primary focus and as a result people and places are marginalized and separated form adjacent land use activities while the latter approach strives to shift the focus to people, placemaking and accessibility by integrating transport and land use activities and striking modal balance through the practice of TOD and complete street design.

Accessibly-based transport and urban planning built on TOD can address the growing challenges of urbanization, motorization trend, urban sprawl, congestion, and pressing transport problems in Addis Ababa. In this regard, the practice of TOD can be used as effective planning instrument for integrating public transport and urban planning. The practicing of TOD and accessibility based transport planning address the three dimensions of sustainability-social goals (access to services and activities), economic
goals (reduction of transportation and energy cost) environmental goals (reducing sprawl-the space and energy demand (environmental footprint), GHG emissions and air pollution).

High capacity public transport corridor design should be the priority for sustainable urban development in emerging and developing cities so that they can respond to the rapid urbanization, congestion and rise of transport fuel (LTPA, 2010). TOD that is tuned to the urban context of Addis Ababa and specific characteristics of the area/urban corridor is required to improve the performance of public transport and the urban environment of the city. This can be done through corridor design and prioritization of PT and walking over individualized motor traffic. However, the design of potential corridors for PT networks is challenged by uncoordinated local urban planning practices, land acquisition process (land preservation), financial constraints and lack of strong political will that prioritize PT over individual motor traffic in the planning and design of transport infrastructures.

7.1 Concluding Remarks

*Transport system as function of Greener city: The making of Livable and Greener city*

**Policy instruments for integrating public transport and built environment**

Transport plays a big role in the process of greening a city. The adoption of the right transit technology coupled with accessibility-based transport and urban planning enable cities and their metropolitan areas to reduce their environmental footprint and GHG emissions arising from the unsustainable transport and settlement patterns. The case of LRT-based Stockholm corridor reinforces this as the project of this particular neighborhood managed to shrink its environmental footprint to 1/3 (Cervero and Sullian, 2011) by developing the brown field in to compact and mixed use buildings that are configured around the transit boulevard.

The prioritization of public transport and practice of effective policy instruments like TOD, complete streets design, and placemaking enable cities and their citizens at large to create green, livable and vibrant urban environments. Many cities in the world have set out a vision that revolves around public transport particularly LRT and BRT lines in order to address the problems of urban sprawl, congestion, environmental pollution and high energy consumption. Prioritization of public transport and green modes (walking and cycling) in the physical design and planning of roads is crucial towards the making of greener and livable city.
Accessibility and the City

In the domain of transport and built environment, accessibility is a function of quality of transport system and land use configurations and thus it is a measure of easiness with which a person can reach a desired destination by a certain mode of transport. Transits are the backbone of sustainable and green metropolitan city regions (Farr, 2008). And TOD is an effective planning instrument where accessibility of neighborhoods and city regions can be enhanced through the building of transit-based, pedestrian-friendly, compact and mixed-use urban environments. Access to destinations and people, not automobile should be the priority in the design of urban streets and city centers (Toth, 2011).

Thinking beyond the car: Designing Complete streets

Streets have lost their pedestrian character as cars take control of the urban spaces as a result of motorization trend that took off since WWII. This is the case particularly in American cities and in many European cities except in Netherlands who have manage to retain their pedestrian and cycle oriented street pattern. Even in the 20th century, the purpose of street design in New York was to provide as much lanes as possible to move cars from origins to destinations and in many ways, the street design practice is tailored to the provision of extra car lanes by narrowing of sidewalks (Smith, 2010; Farr, 2008). The streets of Addis Ababa are also far from being pedestrian-friendly as more than 65% of the road network is not pedestrianized and where pedestrian facilities are available, they are usually too narrow to accommodate the large mass of walking people. Cycling is not popular in Addis not because of topographic reasons as it is usually argued, but because there is policy neglect/less priority for non-motorized modes in the physical design of road infrastructure (refer section 3.3.2). The case study of the new Bole road also shows this reality. Around 80% of the 40m wide road space is allocated to motor traffic making it unattractive and unfriendly for the users of the most sustainable and green modes of transport- public transport customers, pedestrians and/or cyclists. Transportation planning that prioritizes cars and mobility over people and accessibility is no longer viable. The prioritization of public transport and provision of adequate pedestrian facilities and cycle paths at neighborhood and urban streets is an integral part of sustainable transport planning.

Livable and accessible urban environments are achieved when the different modes of transport are represented appropriately at street level. The transect of street network and the respective allocation of road space to different modes varies as one moves from neighborhood streets to urban streets. The pedestrian-friendly neighborhood street is 10 to 15m wide with more than 50% the road space allocated for pedestrians (Omari, 2010). The share of pedestrian space decreases with increase of urban intensity. The bus way/tram street is usually 30-40m wide with public transport taking 30 to 40% of the share, cars 30 to 40% and pedestrians and/cyclists 25 to 30%.
As outlined in the chapter 2, transportation interfaces, context-based mixed use developments, high quality public spaces and walkable and green environments are the defining elements of complete streets. Complete streets are designed with wider perception of the broad spectrum of road users in mind: pedestrians, cyclists, motorists and public transport users. And this requires thinking beyond the conventional way of designing streets just on the physics of moving cars from A to B. Streets are public spaces too not just raceways. Complete streets are effective instruments for integrating transportation and adjacent land use activities (Toth, 2011, Farr, 2008). The coupling of transportation interfaces and land use activities in complete street design enable to create places of high accessibility and vibrant street life.

The case study of LRT-based corridor of Stockholm reinforces the benefits of designing complete streets. Striking modal balance, placemaking and enhancing accessibility are the main purposes of complete street design. Making people the center of attention in the planning and design of urban and neighborhood streets as shown in figure 7-1 changes the look and feel of a place and most importantly it will boost the productivity of the place by attracting social and economic activities of different kinds. Streets are destination too and thus should be designed as safe and convenient places for peoples of all ages and capabilities. And it must be noted that “transportation is the journey and enhancing the community is the goal” (Toth, 2011).

**Public Transport Networks as tools for public space and green areas-Placemaking**

There is often high competition for environmental space in urban areas and this makes it difficult to get a separate place for green areas and public spaces. This is even more observed in cities like Addis Ababa where the urban fabric is tight and streets are narrow. Among the range of public transport technologies, light rail ways and bus ways constitute effective tools for placemaking. They enable longitudinal placemaking
that changes the look and feel of urban space. Greening the space between guiderails and lanes improves the environmental quality of urban areas and streets. Addis Ababa can revitalize its city centers by using its LRT and BRT corridors and complete street design policy which together play an important role in the process of greening the city and therefore can be regarded as effective policy instruments for the city of Addis Ababa to live up to its name-new flower.

7.2 Recommendations
The research tried to address growing urban challenges and transport problems in the city of Addis Ababa. The contemporary urban development practices and transport planning and design practice have been explored and evaluated on the basis of indicators established through literature review and knowledge gained from experiences and available data. It identified deficiencies and possibilities for strengthening the role of integrated public transport networks and improving the design of road infrastructure through case studies. A comprehensive and robust result, however, requires extended time and a holistic approach to the field of public transport and urban planning. This may lead to the analysis of the integrity of the main transportation corridors and the effect of ring road on citywide accessibility and mobility. The identification of potential gaps and opportunities in the utilization of these urban infrastructures calls for further research in the following areas.

Urban planning around Transit corridors
Improving the urban and transport planning through corridor design with more focus on the two major LRT transportation axes and proposed BRT corridors of the city is a primary and an overarching issue that the city need to address. This requires coordination among the key urban development actors - transport authorities, planners, and potential developers and individuals. Apart from political will, financial resources and strong institutional frameworks, implementation of the 2005 Transport Master Plans at large requires better understanding, cooperation and participation of the various actors including the public at various levels throughout the planning and implementation processes.

It is often difficult and costly to adjust or plan public transport networks to an existing city structure. Therefore, the identification of potential transit corridors and reservation of right of ways should precede the planning and/or construction of large scale housing projects. A number of condominium housing and real estate projects have been undertaking both in open urban spaces and on greenfields at the outskirts without the prior provision of public transport in mind. This trend of developing the city without having its structural framework in place or in plan should be reversed. It is for this reason that the author recommends and highlights the importance of practicing transit oriented development (TOD) in Addis Ababa.
Competent Transport infrastructure—Improving the Road network for all users

Addis Ababa is a walking city however; there is a clear policy neglect for pedestrians in design of new streets or upgrading of the existing road network. The 2004 completed ring road and the case study of the new Bole road reflects the reality of inadequate provision of pedestrian facilities. And to this practical problem the author recommends in particular the Addis Ababa City Road Authority to implement complete street design as effective policy instrument. The representation of dedicated bus lanes, adequate pedestrian facilities and/or cycle paths at street level makes it possible to improve the performance of the city buses and the newly introduced articulated buses so that they can effectively serve as feeders to the foreseeable LRT and BRT corridors. It should be noted that it is the network of corridors not the identification or presence of few radial corridors that makes efficient and effective public transport possible at urban and regional level. The objective of catering enhanced accessibility and mobility at large demands better integrity of the existing/planned road network to the ongoing and proposed PT networks at street level. The building of competent transport infrastructure that is well integrated to the PT networks will open the opportunity for promoting sustainable urban development in the city so that it can deliver decent transport service/alternatives to the citizens and pave the way towards living up its name.
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