Title: Street Infrastructure Planning

[The Case of Adama Town Ring Road to Kidane- Mihiret Church through Derartu Square]

Asia Esa

A Thesis Submitted to

Department of Architecture, Urban Design and Planning

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirements for the Degree of

Master's in Urban Planning and Design

Office of Graduate Studies

Adama Science and Technology University

Adama

June, 2019

Title: Street Infrastructure Planning

[The Case of Adama Town Ring Road to Kidane- Mihiret Church through Derartu Square]

Asia Esa

Advisor: Dr Berhane Mehary [PHD]

A Thesis Submitted to

Department of Architecture, Urban Design and Planning

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirements for the Degree of

Master's in Urban Planning and Design

Office of Graduate Studies

Adama Science and Technology University

Adama

June, 2019

Approval of Board of Examiners

We, the undersigned, members of the Board of Examiners of the final open defense by **Asia Esa** have read and evaluated her thesis entitled "**Street Infrastructure Planning" [The Case of Adama Town Ring Road to Kidane-Mihiret Church through Derartu Square]."** and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement of the Degree of Master's in Urban Planning and Design.

Supervisor/Advisor	Signature	Date
_____	_____	_____
Chairperson	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date
_____	_____	_____

Declaration

I hereby declare that this M.Sc Thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

Name: Asia Esa
Signature: _____

This M.Sc Thesis has been submitted for examination with my approval as thesis advisor/supervisor.

Name: Dr Berhane Mehary [PHD]
Signature: _____

Date of submission: ----------

Supervisor's/Advisor's approval sheet

To: Architecture, Urban Design and Planning Department

Subject: Thesis Submission

This is to certify that the thesis entitled **"Street Infrastructure Planning" [The Case of Adama Town Ring Road to Kidane-Mihiret Church through Derartu Square]."** submitted in partial fulfillment of the requirements for the degree of Master's in Urban Planning and Design., the Graduate program of the department of Architecture, Urban Design and Planning, and has been carried out by Asia Esa Id. No A/PR 15323/10, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby she can submit the thesis to the department.

Name of major Supervisor/Advisor	Signature	Date
_____	_____	_____

ACKNOWLEDGEMENT

Above everything, I thank my Almighty Allah for being and guiding me all the time during my academic study and at the time of this research.

I am grateful to my advisor, Dr Berhane Mehary [PHD] for his overall and unlimited support. It is also my pleasure to acknowledge officials of the Adama Town Administration and the residents who have been willing to assist in providing me information without reservation.

My thanks and appreciation goes also to my husband Sami Kemer for his all-rounded financial, technical & moral supports.

Contents

CHAPTER **PAGE**

LIST OF TABLES

TABLES **PAGE**

LIST OF FIGURES

FIGURE **PAGE**

Abstract

Adama is strategic and a largest business corridor with a is high rate of in and out movement of peoples per day. This accounts poor street infrastructures provision on main streets of the Town. Higher conjunction and absence of pedestrian's ways creates dissatisfaction of residents and street users. The study uses data collection methods like questionnaire, interview, focus group discussion and direct observation to get concrete and useful data for the research subject. General objective of the research is emanated from current problems existing in Adama Town Ring Road to Kidane-Mihiret Church through Derartu square and thus: to identify the major problems regarding street infrastructures planning and to look for better ways of plan and design preparation and implementation that suits the socio-economic and physical environment of the town in particular and the country in general. The major finding of this paper is the gap between plan formulating and approaches to realize street infrastructure planning, un-integration of various stake holders who work on infrastructure planning and expansion results chaotic environment which is not comfortable for residents and incurs unexpected cost on municipalities.

- **Key Words: Street Infrastructure, Roundabout, Drainage, Pedestrian**

CHAPTER ONE

1. INTRODUCTION

Current scenario indicates that Ethiopia's urban population growth is among the highest in the world. Nevertheless the country is still one of the least urbanized in Africa. Addis Ababa is a single primate city which consisted of 30% of the countries urban population (Kassahun and Tiwari, 2014). Ethiopia's current urbanization level of 19% is projected to steadily increase to at least 30% by 2030 (EDRI and GGGI, 2015). Even if urbanization is low in Ethiopia, it is growing rapidly by African standard (Tegenu, 2010).

The rapid growth in population is a challenge as well as an opportunity to Ethiopia's effective management of urbanization. It is a challenge in a sense that it would increase pressure on infrastructure provision in the country in general and in urban centers in particular. It would be an opportunity through its influence on national market and labor force provision. The 2007 Population and Housing Census results show that the population of Ethiopia grew at an average annual rate of 2.6 percent between 1994 and 2007 a decrease of 0.2% from the annual growth rate during the previous period (1984-1994) (Statistical report of 2007).

The urban centers in Ethiopia have their own distinctive features. Some of them are located on hills for purposes of military strategy, and for their scenic beauty. The cities have tended to develop into service centers prior to becoming industrial centers. Due to the impacts of globalization, cities become industrial centers with too much occupants of the working group.

Recently, large and medium urban centers in Ethiopia have exhibited a remarkable growth in construction, manufacturing and tourism sectors. Naturally urbanization occurs as a result of industrial development with subsequent demand for labor and growth in demand for varied services and goods. It is also caused by push factors from rural areas mostly scarcity of agricultural land and job opportunities. Hence rural labor migrates to nearby urban areas in search of jobs (Kassahun and Tiwari, 2014).

The urban development policy, good governance and industry packages were developed based on the principle that cities should have an accelerating and encouraging role in local and national growth. Urban infrastructure development was part of the five years national plan for accelerated and sustainable development to end poverty (PASDEP) for the years 2005-2010 (MoFED, 2006). **"**By examining the policies, program and outcomes that lead to urban development, we observe a significant improvement in terms of job creation, housing provision and wealth creation in large and small urban centers. Moreover, the existing policies and strategies provide a framework for sustainable development**"** (Kassahun and Tiwari, 2014).

Public investment in infrastructure is aimed at increasing the productivity and purchasing power of urban centers. Significant improvement is seen in investment along all lines of infrastructure in the country in general and urban centers in particular. The stock of street network is growing at an encouraging pace (Ibrahim, 2011).

The Government of Ethiopia has been working to improve quality of life for urban dwellers and increase productivity of urban economies so as to ensure contribution from urban centers for growth of the national economy. Integrated infrastructure development plan plays important role to effectively guide and promote urban development. But urban infrastructure is often subject to haphazard planning; disjoint implementation and poor installation management. Moreover, the provision of infrastructure is inadequate and poor in most of the urban centers and its development is lagging behind the population growth rate. In general, major challenges in infrastructure provision are categorized under physical and technical constraints; economic and financial constraints; institutional and structural constraints (Solo, et.al, 1993). Similarly, governance and political economy of urban service delivery is a major concern to date. But what are the major challenges in the context of urban centers such as Adama Town and what prospects do they have to ensure improved welfare for its dwellers and increase productivity in urban economic system? Questions of this sort need critical analysis through case studies. Hence, this study strives to evaluate major challenges in provision of street infrastructure planning in Adama city. Street infrastructure planning is related with main issues like, public utilities, hierarchy of circulation networks, terminals for major transportation exchange centers, transportation

system, transportation system management and air pollution from vehicles (Street Planning and Design Fundamental).

1.1 Background of the Study Area

Adama is an old city in the Ethiopian standard. Its establishment dates back to and connected with the construction of the Djibouti-Finfinne railway station depot in 1916 G.C. The first or original place for the establishment of Adama town was “Aroge” Adama i.e. old in English and later on expanded down to the current area of settlement. The name Adama is believed to derive from a small milky plant called “Adami” in Afan Oromo, which is to mean cactus tree dominant tree species in the area of “Aroge “Adama during the establishment of the town (source: Adama Town profile by Ato Reshid Mohammed).

In 1936 G.C Adama was not more than a small village with a population of 300 households. Municipal status was given to the city in 1950 G.C after two decades of its establishment. Since then it became one of the flourishing recognized cities in the country that is serving as a gateway to overseas and the main commercial, manufacturing and educational center in the region and that serves as a distribution center for the surrounding areas. Since 1992 G.C. Adama has been the seat of East Shoa Zone administration and Adama Woreda (district) Administration.

Due to its strategic location and centrality to business activity there is high rate of in and out movement of peoples per day. This accounts high traffic flow, congestion and over taxing of the existing main streets that lowers the functionality and serviceability especially in the central part of the city. Currently, the central parts and periphery areas of the city lack proper and well managed streets and street infrastructures. The problem is clearly reflected on main street of the city which functions as major entry and exit point. The incompatibility between current traffic demand and capability of the street contributes higher congestion and inconvenience for users.

Therefore, this research has an insight in ensuring the sustainable and user friendly street infrastructure development and planning of the site under the study.

1.2 Statement of the Problem

Adama is one of the Ethiopian cities in which improper utilization of street infrastructure is visibly seen. The current status of street infrastructure development around the study area is very poor when compared to urban design and urban planning principles. It is not only about comfort, but the impact it results on climate and community around is also very high.

The study area is the main route of the city which is the view from the Adama Town ring road to Kidane-Mihiret Church through Derartu Square. The size of the street is indicated as 40 m on master plan of the town. But, the current street width is only 14 m asphalt and 2 m wide median greenery. The mismatch between the number and type of vehicles and street size leads to a high traffic congestion. Pedestrian ways are abused by adjacent buildings, and some buildings are constructed on gorge which is the main outlet of the town. This results many buildings vulnerable to storm during rainy season. In some part, absence of covered storm water drainage and absence of the setbacks affect the mobility of pedestrian, demolishing of an asphalt street to expand utilities like electric, water and tele lines.

These are major challenges that initiate the researcher to study the area and to set effective and sustainable street infrastructure through the use of urban planning and design concept.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of the research is emanated from current problems existing in Adama Town ring road to Kidane-Mihiret Church through Derartu Square and thus: to identify the major problems regarding street infrastructures planning and to look for better ways of plan and design preparation and implementation that suits the socio-economic and physical environment of the town in particular and the country in general.

1.3.2 Specific Objectives

The Specific Objectives are based on the above general objective; the study seeks to achieve the following specific objectives:

- To analyze the current status of street infrastructure development based on planning standards and total area of the town.
- To identify the impact of improper utilization of street infrastructures on public, private and community.
- To provide inputs for planning and monitoring of street infrastructures.
- To identify factors affecting the plan implementation.

1.4 Research Questions

- What is the current status of street infrastructure in the study area?
- To what extent the existing street infrastructure is functional?
- What is the impact and benefit of Main Street in the study area?
- Do the existing street infrastructures match with the general planning standards of Ethiopia?

1.5 Scope of the Study

The thematic scope of this research focuses on the assessment of current street infrastructure planning trend of Adama Town in relation to goals and objectives set in the research. The spatial or geographic scope of the study covers main road of the city from Adama Town ring road to Kidane-Mihiret Church through Derartu Square. So, the study mainly focuses on finding out the challenges and constraints of street infrastructure planning in the study area and to set a technically and economically viable street infrastructures planning and development project for the study area.

1.6 Limitation of the Study

The limitations, in their descending sequence of difficulties they impose encountered while various stages of research activities developed. The very critical problem is acquiring relevant documents due to its unavailability. High turnover of officials and lack of willingness by few officers to provide relevant data was a major limitation. Finally, limitation of available literature which is directly connected with the study could be pointed out as it imposes a significant impact on the study.

1.7 Significance of the Study

This study attempts to investigate street infrastructure planning practices of the site under the study and to recommend, certain mechanisms as how to improve quality and function of street infrastructures.

Furthermore, this research helps concerned bodies offering relevant role in facilitating and providing important resources and clues to take pro-active actions in the current and future plan and design implementation processes of the study town in particular and other similar cases in general. Moreover, the final findings and output of this paper can also be used as standpoint and spring for further research work in the related sectors and subject matter for others researchers.

1.8 Organization of the Study

This research has five chapters: the first chapter deals with the introduction and gives general overview of street infrastructure planning. Chapter two deals with review of literatures and various findings, studied by different scholars. Chapter three briefly explains about the methodology and research design applied to conduct this study. Chapter four describes analysis and interpretation of data and chapter five deals with design solutions and chapter six describes conclusion and recommendations based on acquired data.

CHAPTER TWO

2. LITERATURE REVIEW

This portion of the research examined some of the definitions and theoretical basis for street infrastructure planning and related empirical articles studied by authors in the field. Hence part one consists of the theoretical literatures and the second part deals with an overview of what has been done so far on the specific area of the research interest at hand.

2.1 Street Infrastructure

2.1.1 Infrastructure

The word infrastructure has been used in English since 1887 and in French since 1875, originally meaning "The installations that form the basis for any operation or system". The word was imported from French, where it means sub- grade, the native material underneath a constructed pavement or railway. The Latin prefix "infra", meaning "below" and many of these constructions are underground, for example, tunnels, water and gas systems, and railways. The army use of the term achieved currency in the United States after the formation of NATO in the 1940s and by 1970 was adopted by urban planners in its modern civilian sense (Infrastructure | Define Infrastructure at Dictionary.com).

It refers to the fundamental facilities and systems serving a country, city, or other area, including the services and facilities necessary for its economy to function. Infrastructure is composed of public and private physical improvements such as streets, bridges, tunnels, water supply, sewers, electrical grids, and telecommunications (including Internet connectivity and street band speeds). In general, it has also been defined as "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions"(Infrastructure | Define Infrastructure at Dictionary.com).

There are two general types of infrastructure named as hard and soft. Hard infrastructure refers to the physical networks necessary for the functioning of a modern industry. This includes streets, bridges, railways, etc. Soft infrastructure refers to all the institutions that

maintain the economic, health, social, and cultural standards of a country. This includes educational programs, official statistics, parks and recreational facilities, law enforcement agencies, and emergency services.

2.1.2 Streets

A Street is a public thoroughfare (usually paved) in a built environment. It is a public parcel of land adjoining buildings in an urban context, on which people may freely assemble, interact, and move about. A Street can be as simple as a level patch of dirt, but is more often paved with a hard, durable surface such as concrete, cobblestone or brick. Portions may also be smoothed with asphalt, embedded with rails, or otherwise prepared to accommodate non-pedestrian traffic (Source: book of urban design and street and square Cliff Moughtin third edition and Cliff Moughtin with Peter Shirley second edition).

A connected street network should facilitate the movement of traffic but also create comfortable spaces for pedestrians. These should be used to encourage attractive, well-functioning, pedestrian-friendly streets throughout neighborhoods. Despite differing widths, purposes, and traffic volumes, all streets are intended to place equal emphasis on safe, comfortable pedestrian movement throughout the neighborhood. Their designs, should incorporate sidewalks, street trees, and a planting strip buffer where appropriate. On-street parking is also desirable to provide convenient access to residences and commercial establishments and to help calm traffic. Bike and transit lanes, where appropriate, are useful to facilitate alternative transportation methods.

Well-designed streets are crucial components of complete and sustainable neighborhoods. Their designs can have great impact on the perception of a neighborhood’s quality of life and can create an element of basic civic pride while linking the neighborhood with the larger community.

2.1.3 Street Infrastructure

Street infrastructure is a very wide concept that refers to an installation of fixed asset including surface streets, pedestrian walkway, street furniture and amenities, bicycle way, greenery, tele lines, electric lines, water lines and etc. Well-designed streets like Figure 1

are crucial components of complete and sustainable neighborhoods. Their designs can have great impact on the perception of a neighborhood's quality of life and can create an element of basic civic pride while linking the neighborhood with the larger community.

Figure 1 : well designed street

(Source: urban street guide, published by Island Press)

2.1.4 Utility and Integration of Streets

Utilities provide basic needs that significantly improve a community's quality of life, spurring social and economic growth. Improper planning and maintenance of utilities, however, can limit the economic viability of an area. Utilities and infrastructure planning and maintenance involve a large number of agencies and stakeholders. Inter-agency coordination, especially when it comes to street works, is critical. Common issues include high costs and lack of cost certainty, complex regulatory processes, lack of coordination, the state of existing utility plans, and spatial impacts. Integrated planning is also critical; the opportunities and vision for landscaping and green infrastructure must be coordinated with the planning of utilities and street infrastructure.

The need for comprehensive planning is exemplified in green infrastructure, an increasingly common approach to managing storm water and natural resources to foster healthier environments. Effective technologies and lighting can help improve the usage and perception of streets, mitigating user conflicts and providing a sense of safety. These technologies are adapted to aid in security and surveillance, and to enhance the user experience through navigation systems, information distribution, and user activated signals (Global Street Design Guide published by Island Press).

2.1.5 Functions of the Street

The street in addition to being a physical element in the city is also a social fact. It can be analyzed in terms of who owns, uses and controls it. The purposes for which it was built and it's changing social and economic function. It also has a three dimensional physical form which, while it may not determine social structures, does inhibit certain activities and make others possible. The street provides a link between buildings, both within the street, and in the city at large. As a link it facilitates the movement of people as pedestrians or within vehicles and also the movement of goods to sustain the wider market and some particular uses within the street. Its expressive function also includes its use as a site for casual interaction, including recreation, conversation, and entertainment, as well as its use as a site for ritual observances.' The suburban street reinforces people's social aspirations: movement 'up market' to a larger house, bigger garden (Source: Urban Design Street and square, third edition by cliff moughin).

2.1.6 Streets as Social Places

"Streets for Everyone"

In any development the design of streets should start by asking "what will happen on this street?" The street should be designed to suit the activities that we would like to see carried out on it.

The re-integration of traffic and other activities is best done by creating a network of spaces rather than a hierarchy of streets. The arrangement of spaces will take full account of the movement framework for the area, including the analysis of vehicle movements. Inevitably there will be some main streets, either within the development or nearby (Source: urban design compendium, third edition by Llewelyn Davies Yeang).

2.2 Components of Street Infrastructure

2.2.1 Form of Street

The configuration, shape or form of the street has not received the detailed consideration given to the design of the public square. Certainly many great streets have been designed and built, many others have been admired, described and photographed, but little work on

the analysis of form has resulted. Although the street accounts for most of the urban Public realm, in practice, particularly modern practice, the street is what remains after private planning of individual properties is considered satisfactory. There are two quite distinct physical conceptions of a European city (Source: urban design compendium, second edition by Llewelyn Davies Yeang).

In the first conception it appears that the streets and public squares are carved from an original block of solid material. The other main conception of a city that has the form of open parkland into which buildings have been introduced as three-dimensional objects sitting on and within the landscape. This is the concept associated with developments like the Ringstrasse in Vienna or the ideas formulated by Le Corbusier and others in the Modern Movement of architecture and planning. (Source: urban design compendium, third edition by Llewelyn Davies Yeang).

Both main concepts exist side by side in the real world of the city and, indeed, as far as the street is concerned, both concepts are of ancient origin being documented by Serlio and Vitruvius in their descriptions of the tragic, comic and satyric scenes. The form of the street can be analyzed in terms of a number of polar qualities such as straight or curved, long or short, wide or narrow, enclosed or open, formal or informal. Street form can also be analyzed in terms of scale, proportion, contrast, Rhythm or connections to other streets and squares. (Source: urban design compendium, third edition by Llewelyn Davies Yeang).

No matter which analysis is followed the street has two main characteristics directly related to form; it is, at one and the same time, both path and place. It is such common practice to regard the street as a place has been quite overlooked.

For many generations the street has provided urban communities with public open space right outside their homes. Jonathon Barnett says “A second element basic to any public open space plan is to recognize the importance of streets as the framework of public open space”. The modern city street has become in some cases a place of danger for citizens or so unattractive that it forces people to stay within the privacy of their homes and move about in the relative sanctuary of the private motor car. For a street to function as a place or exterior room in the city it must possess similar qualities of enclosure as the public square.

2.2.2 Street Proportion

If proportion includes, within its definition, the idea of symmetry as used in the times of Hellenic Greece, then the term when used in street design goes beyond an understanding of the crude ratio of length to width to height: the concept is straitened to include the relationship of the parts of the street to each other and to the proportions of the total composition. It may even include some notion of classical tripartite subdivision into introduction, development and climax. Such formal melodic structuring is more important for the design of the straight street than its picturesque counterpart modeled on the medieval example. 'It, the straight street, offers us a more restricted field of study, its perfection being primarily dependent on a good proportion between its length and width, on the kind of edifices of which it is composed, and on its monumental termination.

The narrow pedestrianized city streets with continuous enclosing walls slightly higher than street width are most successful for their purpose as well as being an attractive place. They are still to be found, despite traffic engineers' best attentions, in cities like Nottingham as well as smaller towns such as Stamford or King's Lynn. When streets are narrow, 6–9 m (20–30 ft) and flanking buildings three or four story's it gives 'the sense of completeness and enclosure to the pictures in the streets.

'Cornilius Tacitus writes that Nero having widened the streets of Rome, thereby made the city hotter, and therefore less healthy; but in other places, where the streets are narrow, the air is crude and raw, and there is continual shade in summer. But further; in our winding streets there will be no house but what, in some part of the day, will enjoy some sun; nor will they ever be without gentle breezes, which whatever corner they come from, will never want a free and clean passage; and yet they will not be molested by stormy blasts, because such will be broken by the turning of the streets' (Source: urban design compendium, third edition by llewelyn davies yeang).

2.2.3 Street Networks

In general streets have two basic traffic service functions. The foremost one is to provide traffic mobility while the subsequent one is to release access. These two functions in turn have inverse relationships. The one with deep and long distance traffic with high and

uniform speeds and un- interrupted traffic flows is directly correlated with mobility. Based on this level of access controls, streets can be classified as:

- **Express way**: It provides for expeditious movement large volumes of through traffic b/n area and across the City not intending to provide land access.
- **Arterial Street**: It provides for the through traffic movement b/n areas and across the city and divert access to the abutting property subject to necessary control of entrance exit and curbs.
- **Collector Street**: It provides traffic movement between major arterial and local street system and direct access to the abutting property.
- **Local Street**: It provides direct access to the abutting property.

2.2.3.1 Street Network Pattern

Different pattern of streets could be planned, based on the planning concept, existing network and the topography (Source: Planning Norms and Standards for Road, Transport and Utility Networks of Ethiopia).

- ❖ **Radial Pattern of Streets**

This kind of pattern tends to channel and concentrate the traffic movement to a square or a place. In this pattern importance is given to the place or square where many streets are converging and most of the traffic is conveyed to the center. Successive ring street pattern is overlaid to facilitate the movement from one radiating street to the others. Centers are emphasized in this kind of pattern. Strong centers could be created in the central areas and around the squares. The radiating streets could also create important vistas and axial views, emphasizing buildings and structures located in the central area and on the ends of the axial views with a monumental and grander effect. Such kind of pattern concentrates business and activities in the central places and squares. Due to these facts traffic flow might be concentrated on squares or in the central area and thereby congestion problem might occur unless alternative linkages are developed. In this case especially ring streets are important to distribute the traffic flows.

- **Grid Pattern of Streets**

In this pattern straight and continuous streets are arranged in a parallel manner with certain spacing, crossing at 90 degree with another row of parallel straight and continuous streets. Traffic flow in this pattern is distributed in every direction. This pattern is simple and easy to adopt and implement. As a result, blocks and plot subdivisions are also simple and efficient in space utilization. However, this pattern has an effect of monotony and lack of hierarchical importance. Through traffic flows (long distance travelers) are encouraged to pass through local streets causing disturbances on residential areas. It might also be difficult to differentiate places (especially for strangers) if proper signs are not available and buildings are similar.

- **Loophole Street Pattern**

This kind of pattern is used especially when there is a constraint for expansion like gorges, mountains etc. on the right and left side of the main street forcing the city and its street network to follow a linear pattern of development (like a bay). In this case loophole street pattern could be convenient to connect the areas along the sides of the main street. This kind of pattern is also designed for quiet residential neighborhoods discouraging through traffic flows with dead ends treated by cul-de-sacs and vicious circles street pattern. In this kind of pattern traffic flow is strictly conveyed to the main street or the collector street. This kind of pattern is fit for linear towns and star shaped towns. However there is a difficulty of getting short-cut paths and alternative routes.

- **Organic pattern of street**

In this pattern of streets are winding forming acute curves and odd junctions. This kind of pattern is observed in spontaneously formed and developed cities and it is usually formed due to unplanned and haphazard development. This kind of pattern fits with difficult topographic conditions that oblige the street network to follow an organic pattern. Narrow passageways and bottlenecks might occur; wastage of spaces, costly for infrastructure provision and congestion could be the disadvantages of such kind of pattern. It could even be difficult for vehicular movement unless the curves are implemented according to standards.

2.2.4 Street Junctions

- **Types of Junctions**

A junction, or intersection, is the general area where two or more streets join. A disproportionate amount of traffic accidents occur at junctions, and thus from a traffic safety aspect junctions require attention and careful design. Good junction design should allow transition from one route to another or through movement on the main route and intersecting route with minimum delay and maximum safety. To accomplish this, the layout and operation of the junction should be obvious to the driver, with good visibility between conflicting movements.

Differing junction types will be appropriate under different circumstances depending on traffic flows, speeds, and site limitations. Types of junctions include:

- **T-Junctions**

The basic junction layout for urban streets is the T-junction with the major street traffic having priority over the minor street traffic. Applications of T-junctions include staggered T-junction, which caters to cross-traffic.

- **Cross -Junctions**

A cross junction has four legs and is present where two highways cross each other. Overall principles of design, island arrangements, use of turning lanes, and other parameters are similar to those used in T-junctions.

- **Roundabouts**

Roundabout favors minimal delays at lower flows and safer than priority junctions. It requires attention to pedestrian movements and accommodation of slow-moving Traffic.

- **Grade-Separation**

It is used for high flows; it results in minimal delays; but it is expensive. Experiences in some countries have shown that converting cross streets into roundabouts can reduce accident costs by more than 80 percent. Where more complex junction layouts involving

the intersection of four or more streets are encountered, these should be simplified by redesign to two junctions, or a roundabout should be used.

Grade separated junctions generally fail into four categories depending upon the number of streets involved and their relative importance. These categories are as follows:

- **Three-Way Junctions**

For some Y-junctions where grade separation of one traffic stream is required, Layout A may be appropriate. The movements associated with the missing leg would have to be channeled to another location. This would only be appropriate of the traffic volumes on the missing leg were slight and were capable of being served by an at-grade junction elsewhere.

- **Junctions of More Than Two Major Streets**

These junctions are difficult to design, operationally difficult, occupy large areas of land and, requiring numerous bridges, are extremely expensive. This type of junction can often be reduced by changes in the major street alignments, which will simplify the traffic pattern, to a combination of the more simple and economic layouts described above.

2.2.5 Parking

Parking is the act of stopping and disengaging a vehicle and leaving it unoccupied. Parking on one or both sides of a road is often permitted, though sometimes with restrictions. There are two types of parking facilities:

- On street facilities: On street curb can be divided into two, unrestricted curb parking and restricted curb parking. The restricted curb parking could be police controlled (through enforcing, restriction, posted sign or meter control).
- Off-street parking facilities: There two basic type of off street parking area, surface lots and multi floor structure.

2.2.6 Street Furniture

Street furniture is a collective term used in the United Kingdom, Australia and Canada for objects and pieces of equipment installed along streets and streets for various purposes. It

includes benches, traffic barriers, bollards, post boxes, phone boxes, streetlamps, traffic lights, traffic signs, bus stops, tram stops, taxi stands, public lavatories, fountains, watering troughs, memorials, public sculptures, and waste receptacles. The design and placement of furniture takes into account aesthetics, visual identity, function, pedestrian mobility and street safety.

If street furniture is properly integrated in the design of a public space, it creates an identity and develops a sense of place around it. Items of street furniture comprising, for example, objects used to facilitate transportation or the use of land adjacent to a street, are commonly used in urban areas with the aim of making the street more aesthetically appealing. However, if it is placed near intersections it may obstruct the view of drivers, especially if crowds develop around them; and if they are close to the street way, they should also not obstruct the sight distance of pedestrians.

The furniture should be selected and set up based on an analysis of the site's current and desired patterns of use, so it can serve its purpose effectively; quality furniture is costly, so it should be used only where it is really needed. There are various approaches to selecting or designing street furniture: for example Figure 2 shows the selection of street furniture and tonal consistency between streets and walkways; or various parts of the streetscape could be designed to serve as artworks in themselves.

Figure 2: Street furniture and street seats

(Source: street furniture.com)

Generally speaking, there are five basic criteria involved in selecting and placing items of street furniture: function (i.e. seeing how necessary an item is and how it can serve its purpose), sitting and layout (i.e. deciding where each item should be places), form and appearance (i.e. making sure there a continuity or at least a linkage between the designs of

different items), durability (given expected usage), and cost (Source: urban design compendium third edition Llewelyn Davies Yeang).

2.2.6.1 The Significance of Street Furniture

Street furnishings create the settings for resting, sitting and eating, and social encounters with others. Such settings may be of great importance to the elderly, those with limited mobility, and adults who have small children; but in addition to their functional aspect, items of urban furniture such as benches and tables in parks and squares can also be socially significant, as they give these sites a comforting and appealing air and draw people in together.

Appropriately selected and placed furniture can draw people to outdoor spaces and add to the pleasure of using these spaces; the main challenge is getting them outdoors, with the aim of making them feel welcome, relaxed, and involved . The quality of urban spaces is indicated by their character and how well they create a sense of identity, as well as by the quality and placement of their street furniture, as can be seen in various cities: London's red telephone booths and Paris' metro entrances, for example, have become iconic and essential to these cities' identities . In addition to their functional and symbolic roles, items of street furniture may also set standards and expectations of quality for the development of the areas where they are found and can serve as talking points for planning (Source: Wolf, K.L. 2006).

2.2.6.2 Pedestrian Zones

Pedestrian zone is also known as auto-free zones and car-free zones, and as pedestrian precincts in are areas of a city or town reserved for pedestrian-only use and in which most or all automobile traffic may be prohibited. Converting a street or an area to pedestrian-use only is called pedestrianisation. Pedestrianisation usually aims to provide better accessibility and mobility for pedestrians, to enhance the volume of shopping and other business activity in the area and/or to improve the attractiveness of the local environment in terms of aesthetics, air pollution, noise and crash involving motor vehicle with pedestrians.

2.2.6.3 Bike lanes (US) or cycle lanes (UK)

It is bikeways (cycle ways) with lanes on the roadway for cyclists only. In the United Kingdom, an on-road cycle-lane can be firmly restricted to cycles (marked with a solid white line, entry by motor vehicles is prohibited) or advisory (marked with a broken white line, entry by motor vehicles is permitted). Figure 3 indicates design of United States, a bicycle lane (1988 MUTCD) or class II bikeway (Caltrans). Bike lane is always marked by a solid white stripe on the pavement and is for 'preferential use' by bicyclists.

Figure 3: Cyclist environment

(Source: https://www.sustrance.org.)

2.2.6.4 Green Infrastructure on the Street

City streets are not just thoroughfares for motor vehicles. They often double as public spaces where people walk, shop, meet, and generally participate in many social and recreational activities that make urban living enjoyable. Urban foresters, designers, and planners encourage streetscape tree planting to enhance the livability of urban streets (Wolf, K.L. 2006).

Green Streets are designed to give priority to pedestrian circulation and open space over other transportation uses, but ensure emergency response for public safety is not adversely impacted. The treatments may include sidewalk widening, landscaping, traffic calming, and other pedestrian-oriented features. The purpose of a Green Street is to enhance and expand public open space, and to reinforce desired land use and transportation patterns on appropriate City street right-of-way.

Green infrastructure provides one of the greatest opportunities for streets and cities to achieve the goal of sustainability. Introducing natural processes for handling water and waste as well as capturing and reusing energy from the sun and wind has a number of advantages and benefits in a streetscape. Adding plants and trees into the streetscape and reducing the amount of hardscape can aid in microclimate control and reduce the urban heat island effect, lowering energy demands from nearby homes and businesses. Improved air quality and providing habitat for animals, such as native pollinators or migratory songbirds, are benefits as well. Similarly, appropriate use of other planting materials, such as mulch, can help hold water and keep roots cool in plants and trees, especially in more arid climates where limiting water use is critical during warm seasons.

Capturing and reusing rainwater, slowing and cleaning storm water, providing additional storm water capacity, and preventing sewer overflows during large rain events results in cleaner and healthier watersheds. It allows for groundwater recharge, aquatic habitat protection and enhancement, and conservation of important and increasingly scarce resource water. In addition, storm water reuse and pollutant removal are being provided by space-saving above-ground and below-ground landscape devices as shown in Figure 4.

Active green infrastructure, such as capturing solar and wind energy, can lower utility costs for local residents and businesses. In addition, active green infrastructure provides resiliency and self-sufficiency at a street or neighborhood level. Generating energy from a clean renewable source (i.e. the sun) versus burning non-renewable, high carbon footprint fossil fuels contributes to mitigating global climate change.

In addition to environmental advantages, localized and efficient green infrastructure also provides a multitude of economic and social benefits. To reduce wear and tear on aging pipe infrastructure, and in the long run, save on maintenance and replacement costs. Moreover, since most green infrastructure systems are visible and above ground, they can actively engage and educate the public about the benefits of creating environmentally friendly infrastructure systems.

Figure 4: Street and greenery

(Source: Google green infrastructure Wikipedia)

2.2.6.5 Curb Extensions

Curb extensions visually and physically narrow the street way, creating safer and shorter crossings for pedestrians while increasing the available space for street furniture, benches, plantings, and street trees. They may be implemented on downtown, neighborhood, and residential streets, large and small. Curb extensions have multiple applications and may be segmented into various sub-categories, ranging from traffic calming to bus bulbs and midblock crossings.

Curb extensions decrease the overall width of the street way and can serve as a visual cue to drivers that they are entering a neighborhood street or area. Curb extensions increase the overall visibility of pedestrians by aligning them with the parking lane and reducing the crossing distance for pedestrians, creating more time for preferential treatments such as leading pedestrian interval and transit signal priority.

2.2.6.6 Street Amenities

Street amenities are publicly available resources, physical or biological, that have an aesthetic, functional, and/or ecological value (i.e. street trees, benches, traffic calming measures and community gardens). Successful streets provide amenities to support a variety of activities. These include attractive waste receptacles to maintain cleanliness, street lighting to enhance safety, bicycle racks, and both private and public seating options the importance of giving people the choice to sit where they want is generally underestimated. Cluster street amenities to support their use.

2.2.6.7 Street Light

It is a raised source of light on the edge of a road or path. When urban electric power distribution became ubiquitous in developed countries in the 20th century, lights for urban streets followed, or sometimes led. Many lamps have light-sensitive photocells that activate automatically when light is or is not needed: dusk, dawn, or the onset of dark weather. This function in older lighting systems could have been performed with the aid of a solar dial. Many street light systems are being connected underground instead of wiring from one utility post to another.

2.3 Street Infrastructure in Urban Design Context

In urban planning and urban design context street infrastructure refers to an installation of fixed asset along the street. But both urban planning and urban design are concerned about providing effective, functional and standard street infrastructures in which the street user gets maximum satisfaction.

In urban planning streets is the major element that defines plots, blocks and city in general. Substandard streets affect city's image and lowers quality life for the residents. In order to attain the maximum outcomes of proper planning like aesthetics, health and comfort urban planning is the major tool.

In urban design street is not only a way but it is major component in maintaining public realm. Based on urban design standards and principles standard street infrastructure means, a street which is composed of standard street width which accommodates calculated amount vehicles without congestion, proper storm and sewerage lines, utility lines, proper street lights to make sure safety and security for street users, street seats and so on.

- **What Makes A Successful Street?**

- **Lighting**: scaled to the pedestrian provides ample light for both the sidewalk and street way. On busier transit corridors, direct street way lighting on consistent, multi-functional light standards, are appropriate.

- **Sidewalks**: can vary in width and material depending on the type of street. Commercial areas should generally have wider sidewalks to allow safe pedestrian movement.
- **Signage**: that identifies establishments, directions, and locations should be simple and oriented to the pedestrian, not merely the automobile.
- **Bus stops**: that is highly visible, inviting, and placed a safe distance from the curb provide comfortable mass transit accessibility.
- **Street furniture**: in commercial areas provides necessary amenities for pedestrians. Benches, bike racks, planters, bollards, tree grates, and water fountains create a comfortable outdoor environment.

2.3.1 Unity in Street Design

There are a number of factors which contribute to a unified street design, possibly the most important being that the form of the buildings should appear as surfaces rather than as mass. When buildings take on strong three-dimensional form the mass of the buildings dominates the scene and the space loses its importance. When the buildings ranged along a street have varied forms, styles and treatment the space loses definition.

Unified street shown in Figure 5 express the relationship of spatial volume to figural position against a background of two-dimensional planes, walls, pavement and sky above.

Figure 5: Unified street design

(Source: Google public space amenities salvaging creativity .com)

2.4 Qualities of Good Streets

A quality of street is measured by the following points.

- If it provides orientation to its users, connects well to the larger pattern of ways, balances the competing needs of the street driving, transit, walking, cycling, servicing, parking, drop-offs.
- Fits the topography and capitalizes on natural features and lined with a variety of interesting activities and uses that create a varied streetscape.
- Relates well to its bordering uses allows for continuous activity, doesn't displace pedestrians to provide access to bordering uses.
- Encourages human contact and social activities. Employs hardscape and/or landscape to great effect.
- Promotes safety of pedestrians and vehicles and promotes use over the 24-hour day.
- Promotes sustainability through minimizing runoff, reusing water, ensuring groundwater quality, minimizing heat islands, and responding to climatic demands.
- Is well maintained, and capable of being maintained without excessive costs. Has a memorable character.

2.5 Factors Affecting Street Design

2.5.1 Human Factors

Street users can be defined as drivers, passengers, pedestrians etc. who use the streets and highways. Together, they form the most complex element of the traffic system. The human performance varies from individual to individual. Thus, the transportation engineer should deal with a variety of street user characteristics. For example, a traffic signal timed to permit an average pedestrian to cross the street safely may cause a severe hazard to an elderly person.

Thus, the design considerations should safely and efficiently accommodate the elderly persons, the children, the handicapped, the slow and speedy, and the good and bad drivers.

2.5.2 Variability

The most complex problem while dealing human characteristics is its variability. The human characteristics like, ability to react to a situation, vision and hearing, and other physical and psychological factors vary from person to person and depends on age, fatigue, nature of stimuli, presence of drugs/alcohol etc. The influence of all these factors and the corresponding variability cannot be accounted when a facility is designed. So a standardized value is often used as the design value. The 85th percentile value of different characteristics is taken as a standard. It represents a characteristic that 85 per percent of the population can meet or exceed. For e.g.; if we say that the 85th percentile value of walking speed is about 2 m/s, it means that 85 per cent of people has walking speed faster than 2 m/s. The variability is thus fixed by selecting proper 85th percentile values of the characteristics.

2.5.3 Street Surface

The type of pavement is determined by the volume and composition of traffic, the availability of materials, and available funds. Some of the factors relating to street surface like street roughness, tire wear, attractive resistance, noise, light reaction, electrostatic properties etc. should be given special attention in the design, construction and maintenance of highways for their safe and economical operation. Unfortunately, it is impossible to build street surface which will provide the best possible performance for all these conditions. For heavy traffic volumes, a smooth riding surface with good all-weather anti-skid properties is desirable. The surface should be chosen to retain these qualities so that maintenance cost and interference to traffic operations are kept to a minimum.

2.5.4 Lighting

Illumination is used to illuminate the physical features of the street way and to aid in the driving task. A luminary is a complete lighting device that distributes light into patterns much as a garden hose nozzle distributes water. Proper distribution of the light flux from luminaries is one of the essential factors in efficient street way lighting. It is important that street way lighting be planned on the basis of many traffic information such as night vehicular traffic, pedestrian volumes and accident experience.

2.5.5 Roughness

This is one of the main factors that an engineer should give importance during the design, construction, and maintenance of a highway system. Drivers tend to seek smoother surface when given a choice. On four-lane highways where the texture of the surface of the inner-lane is rougher than that of the outside lane, passing vehicles tend to return to the outside lane after execution of the passing maneuver. Shoulders or even speed change lanes may be deliberately roughened as a means of delineation.

2.5.6 Pavement Colors

When the pavements are light colored (for example, cement concrete pavements) there is better visibility during day time whereas during night dark colored pavements like bituminous pavements providing more visibility. Contrasting pavements may be used to indicate preferential use of traffic lanes. A driver tends to follow the same pavement color having driven some distance on a light or dark surface; he expects to remain on a surface of that same color until he arrives a major junction point.

2.5.7 Night Visibility

Since most accidents occur at night because of reduced visibility, the traffic designer must strive to improve nighttime visibility in every way he can. An important factor is the amount of light which is reflected by the street surface to the drivers' eyes. Glare caused by the reaction of oncoming vehicles is negligible on a dry pavement but is an important factor when the pavement is wet.

2.5.8 Geometric Aspects

The street way elements such as pavement slope, gradient, right of way etc affect transportation in various ways. Central portion of the pavement is slightly raised and is sloped to either side so as to prevent the ponding of water on the street surface. This will deteriorate the riding quality since the pavement will be subjected to many failures like potholes etc. Minimum lane width should be provided to reduce the chances of accidents. Also the speed of the vehicles will be reduced and time consumed to reach the destination will also be more. Right of way width should be properly provided. If the right of way width becomes less, future expansion will become difficult and the development of that

area will be adversely affected. One important other street element is the gradient. It reduces the tractive effort of large vehicles. Again the fuel consumption of the vehicles climbing a gradient is more.

2.5.9 Street Furniture Design

The furnishings of urban outdoor spaces should be designed with the needs of the disabled, children, and the elderly in mind, and also to enable triangulation i.e. they should be linked together to stimulate social encounters and encourage people to talk to strangers.

In public spaces this stimulus can be created by the selection and arrangement of the street furniture; for instance, if benches, rubbish bins and telephones are far apart, they may have the effect of drawing people apart, whereas if they are arranged closely linked with other amenities such as a coffee cart, they tend to bring people together quite naturally.

2.5.10 Safety and Security

Furniture items designed for outdoor spaces must be constructed of safe materials and designed to prevent injury, without sharp edges or exposed fasteners. They are usually either attached to the ground with anchor bolts (for example, using surface mounting, i.e. attaching a bench to a concrete slab), or embedded in the ground. Naturally, the technique used for mounting should be decided on in advance, so the furniture can be made accordingly.

The type of furniture and its arrangement should also take into account visibility and sightlines, lighting, and accessibility issues that may be faced by women, children, the elderly and the disabled. Areas which are unsafe or pose risks should be designed taking these factors into consideration.

2.5.11 Materials Used in Street Furniture

Furniture selection and design should take into account weather effects such as sunlight, expansion and contraction, wind stress, moisture, and in some cases, salt spray, frost, or ice. The best designs usually incorporate strong, simple shapes, native materials, and natural finishes,

- Design Requirement for street junction

❖ Location of Intersection

The junction should be sited so that the major street approaches are readily visible. On major links of vehicle only or high order mixed usage streets requires a minimum space of 500 m. On local streets spacing of junctions should be that they are not so close to generate a queue of traffic extending beyond the next upstream junction.

The followings should be considered when locating intersection of streets.

- Intersections on major links of vehicle only or high order requires a minimum space of 500m mixed usage streets.
- On local streets spacing of intersections it should be not so close to generate a queue of traffic extending beyond the next upstream intersection.
- Generally an intersection should not be located on a curve with a super elevation greater than 6 percent.
- An intersection should not be located on grades steeper than 3 percent.
- Lateral obstruction of sight distance should also be considered when the location of an intersection is being determined.
- Preferably, streets should meet near or at right angles.
- Angels of skew between 600 and 1200 are desirable for passenger cars.

2.6 Factors Influencing the Choice of Roundabouts

The following factors influence the choice of selecting a roundabout over some other form of intersection control (Source: David Schrank and Tim Lomax, 2003 Urban Mobility Report).

❖ **Safety**: roundabouts should not be introduced on urban streets where the design speeds of adjacent sections are 90 km/h or greater. For design speeds approaching 70 this value consideration should be given to the use of rumble strips and warning signs at the approaches to warn the driver to anticipate the roundabout.

❖ **Traffic Flow**: high proportions of turning movements favor roundabouts. Roundabouts should generally be used if the minor street flow is greater than one

third of the major street flow. Roundabouts are also an advantage where peak flows are 50 percent greater than the average flows.

- **Site Conditions**: roundabouts generally take up more land than fully canalized junctions do. The additional land acquisition costs for roundabouts should be balanced against the increased capacity offered.
- **Driver Behavior**: roundabouts regularize traffic flow and should reduce accidents as well as increase capacity.

2.6.1 Streets and the Pedestrian Environment

It is a useful approach to design the pedestrian environment using the 'Five C' principles:

- **Connections**: do good pedestrian routes connect the places where people want to go?
- **Convenience**: are routes direct, and are crossings easy to use? Do pedestrians have to wait more than 10 seconds to cross streets?
- **Convivi**al: are routes attractive, well lit and safe, and is there variety along the street?
- **Comfortable**: what is the quality and width of the footway, and what obstructions are there?
- **Conspicuousness**: how easy is it to find and follow a route? Are there surface treatments and signs to guide pedestrians?

- **Standards for Pedestrian Ways**
  - Pedestrian ways should be provided on both sides of arterial streets.
  - For collector and local streets provision, local development plans, detail plans, and other studies applicable should indicate location and size of pedestrian ways.
  - Pedestrian ways should be raised 15-20 cm above the carriageways.
  - Minimum drainage slope for such streets should be 2.5 percent.
  - The capacity of footways should be 30 to 50 persons per minute per meter width after deducting approximately 0.9 m dead width in shopping areas and 0.45m elsewhere.
  - The gradient of continuous ramps should not be steeper than 10 percent.
  - Minimum height of 2.3 m should be provided for pedestrian ways.

2.6.3 Cyclists

“It’s good to walk”

A safe, attractive and well cared street for public realm will encourage people to walk. The key considerations are:

- People prefer to walk along streets where they can be seen by drivers, residents and other pedestrians.
- If segregated footpaths are provided, they need to be well-connected and overlooked by houses and other buildings.
- All measures that slow traffic help pedestrians feel safer. At junctions, the use of raised surfaces and tight radii make it easier for pedestrians to cross.
- Well-designed shared surfaces avoid conflicts of movement yet encourage other activities to take place. To achieve this, subtle variations of material or bold changes of detail are appropriate, depending upon the location.
- Footpaths should lead where people want to go, rather than follow a preconceived geometry.
- Footpaths in new developments should be positive, direct and barrier-free.

- **The Cyclist Environment**

“Design for Convenient Cycling”

Cyclists need clear, direct routes which take them to the shops, school or station without stopping short at awkward junctions or obstacles (source: urban street guide, published by island press).

- On low-speed streets (below 30 kph: 20 mph) cyclists can mix with vehicles.
- On busy streets, where there may be higher traffic speeds (30-50 kph: 20-30 mph) there should be clearly defined cycle lanes.
- Separate cycle tracks are a major incentive for people to cycle, and should be introduced where space allows.

- **Cycle Lanes**

Traffic-calmed streets are ideal for cycling, especially where the speed reducing features have been designed as part of the overall layout rather than treated as later additions. On busy streets, or where it is difficult to reduce traffic speed, separate cycle lanes should be provided, with special provision at junctions. These routes should be clear and coherent: disjointed sections of cycle route are ineffective.

On wide pavements, pedestrians and cyclists can share the same space, but an arrangement with a raised curb or clear markings is helpful to segregate cyclists from pedestrians. This arrangement also has distinct advantages for blind and partially sighted people.

2.7 Street Design Elements

The elements that make up city streets, from sidewalks to travel lanes to transit stops, all vie for space within a limited right-of-way. Transportation planners and engineers can use this toolbox to optimize the benefits the community receives from its streets.

2.7.1 Lane Width

The width allocated to lanes for motorists, buses, trucks, bikes, and parked cars is a sensitive and crucial aspect of street design. Lane widths should be considered within the assemblage of a given street delineating space to serve all needs, including travel lanes, safety islands, bike lanes, and sidewalks. Each lane width discussion should be informed by an understanding of the goals for traffic calming as well as making adequate space for larger vehicles, such as trucks and buses.

Travel lanes are striped to define the intended path of travel for vehicles along a corridor. Historically, wider travel lanes (11–13 feet) have been favored to create a more forgiving buffer to drivers, especially in high-speed environments where narrow lanes may feel uncomfortable or increase potential for side-swipe collisions. Lane widths less than 12 feet have also historically been assumed to decrease traffic flow and capacity.

2.7.2 Sidewalks

Sidewalks play a vital role in city life. As conduits for pedestrian movement and access, they enhance connectivity and promote walking. As public spaces, sidewalks serve as the front steps to the city, activating streets socially and economically. Safe, accessible, and well-maintained sidewalks are a fundamental and necessary investment for cities, and have been found to enhance general public health and maximize social capital. Just as street way expansions and improvements have historically enhanced travel for motorists, superior sidewalk design can encourage walking by making it more attractive.

2.7 Sidewalk Design

The sidewalk is the area where people interface with one another and with businesses most directly in an urban environment. Designs that create a high-quality experience at street level will enhance the economic strength of commercial districts and the quality of life of neighborhoods.

2.7.4 Frontage Zone

The frontage zone describes the section of the sidewalk that functions as an extension of the building, whether through entryways and doors or sidewalk cafes and sandwich boards. The frontage zone consists of both the structure and the facade of the building fronting the street, as well as the space immediately adjacent to the building.

2.7.5 Pedestrian through Zone

The pedestrian through zone is the primary, accessible pathway that runs parallel to the street. The through zone ensures that pedestrians have a safe and adequate place to walk and should be 5–7 feet wide in residential settings and 8–12 feet wide in downtown or commercial areas.

2.7.6 Enhancement/Buffer Zone

The enhancement/buffer zone is the space immediately next to the sidewalk that may consist of a variety of different elements. These include curb extensions, park lets, storm water management features, parking, bike racks, bike share stations, and curbside bike lanes or cycle tracks.

2.8 Phases of Streets Development

The productivity, welfare, and security of both rural and urban people are greatly influenced by the level of infrastructure development in their communities and the infrastructural links to district, provincial, and national centers of administration and commerce. Infrastructural services are social overhead capital facilities and activities that share techno economic features (such as economies of scale and spillovers from users to nonusers) and enhance productive capacities of firms (within agriculture, and nonagricultural industries) and households.

The services provided by infrastructure are known as public inputs, public intermediate goods, or collective factors of production. They are not part of individual utility functions, as are public goods. Rather, these inputs enter firm and household production functions, and they do so in a collective manner. Street examples include public infrastructural services (such as public utilities, public works, and other transport sectors) and the provision of information. Clearly, such commodities are important, and there has been substantial empirical investigation of their impact (for example, Aschauer 1989; Lynde and Richmond 1992; Shah 1992). Focusing on streets, the largest component of public capital, Fernald (1999) explored the interpretation of the positive correlation between infrastructure and productivity.

Street agencies need to provide street infrastructure that is beneficial for street users, little is known about how the activities of the agencies influence the value creation of street infrastructure. Proper street infrastructure has an advantage in maintaining social, economic and physical aspect.

Although the scope of the street infrastructure planning is wide in concept, several distinct terms and concepts are critical for the understanding of the role of street infrastructures in enhancing quality of life for the community.

Various findings proved that history of street infrastructure planning in African situation is at early stage. Due to lack of integration and lack of awareness, budget constraint many infrastructure facilities are not properly function. Street infrastructure planning has to do more with installation of fixed asset on the ground so, while installing there should be

careful analysis and integration with in sectors dealing with infrastructure planning and expansion.

In Ethiopia, the experience of integrating infrastructure in the way one can't interrupt the other is not yet practiced. In the case of my study area, a problem related with infrastructure which community always complains is the incompatibility of vehicles way and building structures around.

2.9 Challenges and Opportunities for Developing Standard Street Infrastructure

To develop standard street infrastructures in developing countries like Ethiopia there are number of significant challenges. The major one is cities are not well planned from the period of their emergency. Some cities are planned traditionally by queens or emperors without scientific back ground.

During developing standard street infrastructure demolishing or dismantling previously constructed infrastructures will happen. This leads high compensation and relocation cost and creates social disorder. But, the opportunities are bringing sustainable development and providing aesthetically pleasant, comfortable and long lasting based on urban planning and design principles and standards.

2.10 Importance of proper Infrastructure and Circulation

Social aspects: Level of infrastructure provision influences the services that inhabitants get in an area. It may even be an indicator of who inhabits a certain area. The circulation system influences the way people and goods move within the urban area. It should be accessible to all people-the elderly, handicapped, the poor, and the young.

Economic aspects: Accessibility of urban areas affects value of properties. The convenience provided by infrastructure and circulation systems makes an area to develop or to decline. Urban areas must be properly provided with necessary utilities and circulation facilities.

Physical aspects: Circulation space is the major form-giver for urban areas. The different Circulation systems and the transportation exchange centers provide paths and nodes for urban areas. Proper combination of these elements promotes the hierarchical development.

2.11 Case studies

2.11.1 Las Ramblas Gothic Quarter Barcelona, Spain.

2.11.1.1 History and Background

What is now Las Ramblas used to be a riverbed; a wall there marked the limits of medieval Barcelona. By the 15th century Barcelona had expanded, and the character of the Ramblas was changed. In the late 18th century, construction began on the characteristic central pedestrian promenade, which replaced a section of the city wall. By 1856, all remnants of the old city wall had been torn down and Las Ramblas, by then Barcelona's main thoroughfare, looked much as it does today. Las Ramblas are rich in tradition and history. The ‘Font de Canaletas’, an old iron fountain at the beginning of the public path, has an associated legend: all those who drink from it are truly of Barcelona. The monument of Columbus at the waterfront end speaks to Spain's glorious imperial days. And the Ramblas itself, including the Placa de Catalunya at its head, has a secure and storied reputation as a center of high society, debate and discussion, and people-watching -so much so that it has actually entered the Spanish vocabulary: a "ramblista" is one who along the Ramblas, perhaps making a day of it.

2.11.1.2 Planning/Design Features.

2.11.1.3 Access and linkages

Major thoroughfare connecting central city plazas with waterfront by way of Gothic quarter; extraordinary pedestrian access from central promenade; walkable along entire length (less than one mile); excellent Metro access comfort and Image the proportion of street given over to pedestrians is quite pleasing, as is the harmony between street width, building height, landscaping, and intensity of usage. A mix of activities promotes diverse image and flexible character; Las Ramblas are seen as Barcelona's characteristic, most important, and best streets. Uses and activities Pedestrian paths and sitting area for people-watching, discussions, entertainment, etc.; retail and market space; exhibition space, festivals, bazaars, and Smooth pedestrian walkways of Las Ramblas on street restaurants along Las RamblasLas Ramblas at night with bicycles parking spaces, Trees along Las Ramblas.

2.11.1.4 Demonstrations

Sociability and convivial mixed-use retail and entertainment area promotes sociability between users. Ample seating is provided along central promenade (benches, planters), with additional seating in vicinity of cafes and restaurants. Comfortable atmosphere promotes social contact; Ramblas have reputation as forum for interaction.

2.11.1.5 Design Interventions

A tremendous variety of eateries, shops, markets, and cultural institutions can be found here, along with a huge number of pedestrians and people-watchers. About 1.5 kilometers long, Las Ramblas are really a sequence of three pedestrian-oriented street/boulevards. Its central pedestrian path is unique in many aspects, not the least being its agreeable aesthetics (which come from its pleasant proportions, relative to adjacent development). Landscaping and provision of ample seating are two other big additions. The street is lined with five-to-seven-story buildings, street-level display windows, and many entrances. The central walkway is, on average, 60 feet wide. Sidewalks are usually less than 10 feet wide, encouraging walking in the center. A row of trees separates the central walkway from automobile traffic-two lanes on either side. Pedestrians have precedence: Cars are relegated to narrow shoulder-lanes and must at every turn accommodate pedestrians, who are free of intersections in the central public path. Therefore, pedestrian traffic is always high, partly because of the area's 24-hour attractiveness and partly because of the mixture of activities; regardless of the time of day.

2.11.2 St. Mark’s Place of New York City

2.11.2.1 Background

Although originally designed as primarily residential, it is lined with old brownstones and tenement buildings. St. Mark's Place filled up over the years with businesses on the first and second floors of most buildings, especially between Cooper Square and Second Avenue. In the 1970’s it was the heart of New York's punk rock scene. It has retained some of that image, but styles change, and the surrounding East Village neighborhood has gentrified. When the rock club Coney Island High closed a few years ago, a major part of St. Mark's Place went with it. Gentrification has also brought homogenization, a few years

ago and opened up on St. Mark's. But, while the heyday of its grittiness may be gone, St. Mark's remains a fun and fascinating destination street, and today it is much safer than it was.

2.11.2.1 Planning / Design Features.

2.11.2.2 Access and Linkages

St. Mark's has the ideal design for an urban street; it runs from one public square to another. Cooper Square is where numerous streets converge, and teenagers can be found skateboarding and hanging out on any sunny day. There is also a subway station there. On the other end is Tompkins Square Park. Once blighted, it is now a well-used and popular green space in the center of Alphabet City, New York's trendiest neighborhood. The western most block of St. Mark's can be so crowded as to create impediments to foot traffic, but it is not a street one would choose to walk down in a hurry. There are simply too many interesting things on display in store windows, and too many people with interesting body art, not to stop and take notice. Comfort and image St. Mark's is without question dominated by pedestrians rather than vehicles. It definitely makes a good first impression on anyone interested in streets with diverse urban life on display.

2.11.2.3 Uses and Activities

The range of activities on St. Mark's includes but is not limited to: shopping for any kind of item, eating and drinking, people watching, on the quieter eastern blocks possibly reading, and hanging out and talking. It would be hard to find a corner or gap on St. Mark's that has not been used at one point or another.

Sociability

It is a sociable street, although it is too much a destination for people from all over to constitute a neighborhood street where people know one another. St. Mark's is a meeting place for like-minded individuals from all over the world. Most of the people on St. Mark's at any given time are probably "visitors" in that they live elsewhere in the New York metro area, but many are probably regulars there. There is also a sprinkling of tourists.

2.11.2.3 Design Interventions

St. Mark's Place is vibrant at all times of day. It teems with interesting stores, including numerous record stores and tattoo and piercing parlors. It also has a wide array of bars and eateries, catering to a very mixed crowd. The prime block of St. Mark's, between Second Avenue and Cooper Square, is full of people at all hours, while the beauty of the architecture is more noticeable on the eastern end of St. Mark's, which is quieter.

2.11.3 Mama Ngina Street, Nairobi, Kenya

Kimathi Street is a one Way Street with no permanent car parks just short time parking for may be deliveries. It also has widened pavements ensuring enough space for pedestrians and their safety from auto mobiles.

2.11.3.1 History and Background

Mama Ngina Street borders Kimathi Street's lower end, it also borders Moi Avenue and Muindi Mbingu Street and it is parallel with Kenyatta Avenue. Before it was known as Queensway and changed to Mama Ngina Street after the president's wife. A coffee bar called Act 1 Scene 1 stood opposite the entrance of city hall at travel formerly UTC house. There was and still is also the Twentieth Century Cinema and Barclays Queensway Branch retaining the name of the previous road title. At silo park house, people would park their cars at the basement and cars would be lifted to an elevated parking bay.

2.11.3.2 Planning/design features

Mama Ngina Street is without question dominated by pedestrians rather than vehicles. It was before a two way street which allowed more vehicles and pedestrians were restricted to narrow pavements. The pedestrian walkways were enlarged with well-maintained pavements and it was turned to one way street with no long term parking.

2.11.3.3 Uses and Activities

There is a wide range of activities on Mama Ngina Street which include but is not limited to: work, shopping, eating and drinking, hanging out and talking and at junction with Wabera Street. There are forums of discussing the current politics in the country.

- **Sociability**

Mama Ngina Street is great place to meet and talk with a long lost friend and even discuss official business over a cup of coffee at the Dorman's shop. It is very clean and quiet place, the street is also secure due to the presence of the international companies situated along the street such as Barclays bank, South African Airways and is home to Embassies.

2.12 Lessons Learnt

Street infrastructure needs to be adequate for the effective use of urban space for the wide variety of users i.e. pedestrians, motorists and work and business owners. All streets to be constructed or improved on city rights-of-way shall be reviewed a designated, prior to integrate all components of available infrastructures that suits the physical environment of an area.

Well designed streets encourage all ages of people to walk and enjoy their city with the sense of belongingness.

CHAPTER THREE

3. METHODOLOGY

3.1 The Case Study area

The study is conducted on the inner city area mainly through on site observation and mapping on selected case area. The detailed analysis of the study area is given below in this sub section by describing the location, population, socio-economic status, environmental conditions of the site, reason for selecting this particular site and location maps are presented.

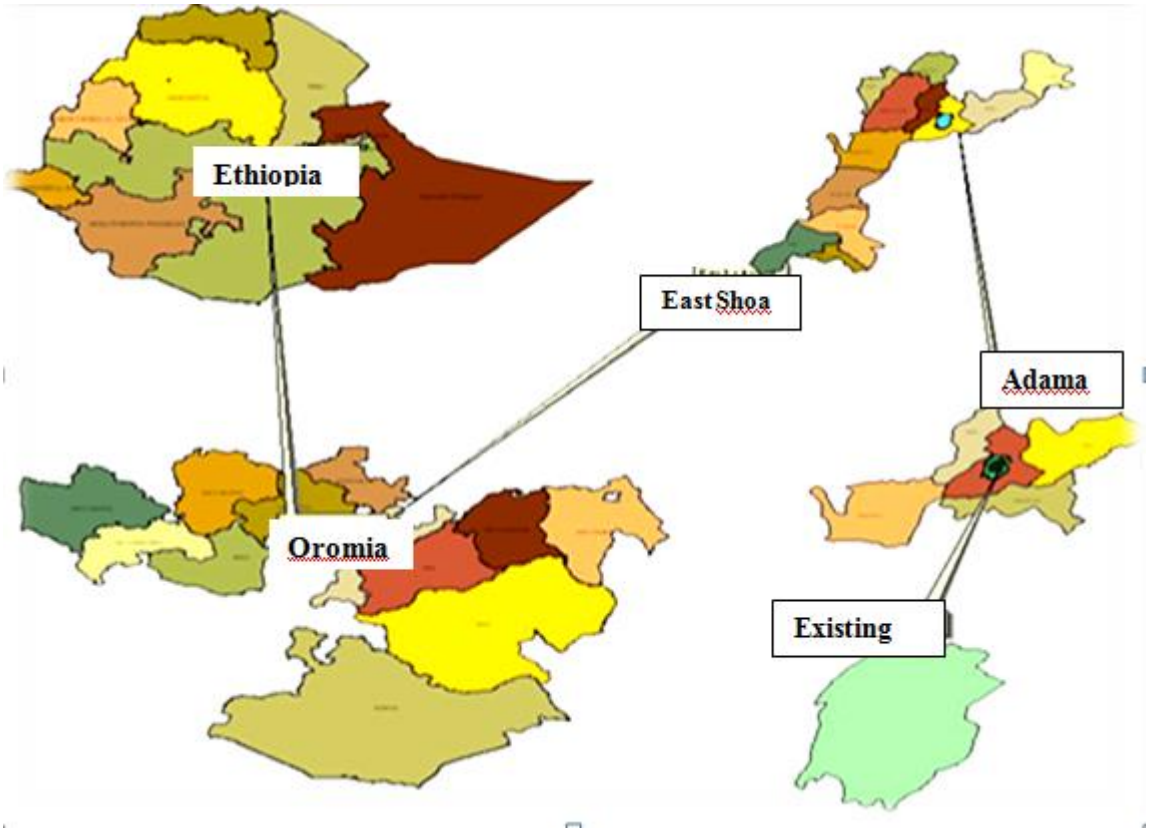


Figure 6: Location map of the Town

(Source: Adama Town profile)

Figure 7: Integration map of the case study area

(Source: author)

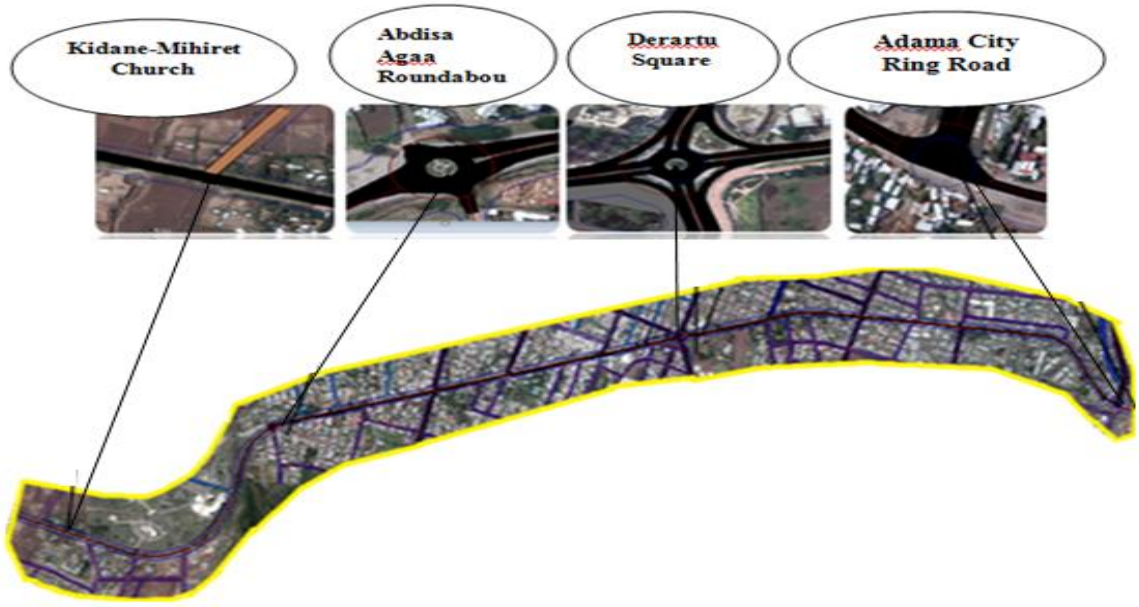


Figure 8: Shows existing features

(Source: author)

3.2 Background of the Study Area

3.2.1 Location

- **Absolute location**

Adama Town is located within grid references point that stretches between 8˚35’00” to 8˚36’00’’ North latitude and $39^0$11'57" to $39^0$21'15" East longitude.

- **Relative Location**

Adama Town is located at some 100 kilometers from Finfinne, on the southeast along the main street to Harar.

3.2.2 Altitude

The Adama Town is located with an elevation ranging from 1460 to 1970 meters above sea level and is characterized by a very flat and plain of lowland rounded by a lot of mountainous. Thus, because of its topographic features, area of the town is deeply deselected by numerous valleys formed by the seasonal rivers crossing the town. These streams are seasonal in nature.

3.2.3 Seismicity

Since the town is located within the Ethiopian Rift Valley Zone seismic hazard risk may be expected. According to the figure 9, Adama Town falls within the zone that is characterized by earthquakes of intensity of 8 mm with probability of occurrence of 0.1 for 100 years return period.

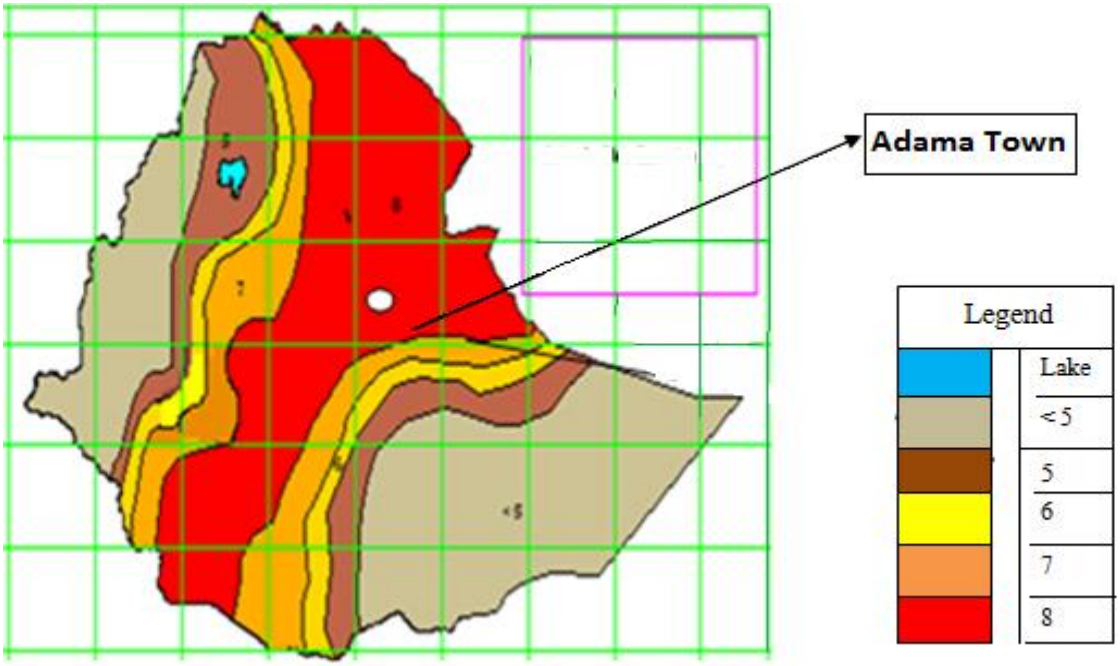


Figure 9: Map showing the location of the study region within the seismic risk zone of Ethiopia

(Source: Adama Town profile)

3.2.4 Temperature

According to information gathered from metrological observation station of Adama, its annual average temperature is 21^0c. Adama is one of the cities that are located in the Rift Valley of east Africa. Intense sunlight splashes and heats the surface of the earth for many months of the year. It is characterized by high temperature of warm and sunny days and scorching sun all the year round that has debilitating effect. There are sunshine and cooling evenings through most of the year.

Table 1: The minimum temperature of Adama (2001-2011)

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean	13.7	14.5	15.1	16.2	16.9	17.5	16.4	16.30	15.6	14.0	13.7	13.1
Variance	0.52	0.99	1.41	0.28	0.85	0.34	0.23	0.46	0.54	0.41	0.44	2.00
STDEv	0.72	1.00	1.19	0.52	0.92	0.58	0.48		0.74	0.64	0.66	1.41

(Source: Adama branch office of Ethiopian meteorological agency)

Table 2: The maximum temperature of Adama

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	26.8	28.5	29.3	29.8	30	29.7	26.4	25.9	27.2	28.0	27	25.9
Variance	0.41	0.78	0.98	0.93	1.2	1.11	1.57	0.29	0.52	0.8	1.05	0.36
STDEv	0.64	0.88	0.99	0.96	1.1	1.05	1.25	0.54	0.72	0.9	1.03	0.60

(Source: Adama branch office of Ethiopian meteorological agency)

3.2.5 Rainfall

The rainfall pattern of Adama is bimodal nature. Rainfall is rare in Adama due to semi-desert nature of the Town. The rainfall creates severe flood risk in the Town that causes much damage in the city every year.

Table 3: The monthly total rain fall of Adama (in mm) (2001-2011)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	2.3	28.5	63.6	54.2	3.9	57.6	196.1	220	108	17.4	12	14
Variance	1160.53	1434.4	2365	956.4	2436.11	489	5004	4830	2345.3	486.5	447	318
STDEV	30.47	37.87	48.63	30.93	49.36	22.1	70.74	69.5	48.43	22.06	21	17.83

Source: Adama branch office of Ethiopian meteorological agency

3.2.6 Wind Direction

Adama experiences perpetual high wind speed that mostly blow from east to west from October to December .The wind causes great dust every year and the soil is subjected to the direct action of wind severely. The presence of this very strong speed of wind favors for the installation of alternative energy source, wind turbine, on the skirt of the city.

3.2.7 Flooding

In many towns of Ethiopia particularly in Adama floods are common sources of complaint from the public and seen practically too. Since Adama is settled in between and on escarped slope, this leads to generalization of greater capacity of runoff and erosion. The flash flood that originates from the surrounding areas of high slope rush down towards the town part and causes damage. The poor resistance of soil characteristic and topographic feature of the site in all over the town and surrounding creates very deep gorges and gullies.

3.2.8 Soil Erosion

Topography and climate are known to be main factors to erosion. The slight soil cover, steep relief, relatively intense rainfall and hot climate are reckoned to favor soil erosion in the area. In fact, the area is highly dissected by gorges and gullies. Therefore flood protection and soil conservation works are great assignment for town administration.

3.3 Site Selection Criteria

The study site is located at the center of Adama Town. The length of street selected under this study is 7.2 km.

The area was chosen for this study for the following reasons

- Due to its strategic location and connectivity
- The selected project site is located in the central part of the Town.
- It has the potential to generate further development due to its strategic location and infrastructure availability.
- It also creates development pressure towards the Northern, Southern, East and West part of the town which is isolated from development for long period of time.
- Moreover it can contribute its share to create sustainable town development.
- The site’s potential to generate municipal revenue: - As this area is central business district and there are services and institutions like Adama Hospital,

Modern Mall, express way and new train terminal, there is high attraction toward an investment and hence generate municipal revenue.

- High vulnerability to storm and loss of property during rainy season
- Due to improper storm water mater management, clogged drainages by solid and liquid wastes and informal settlements at the edge of gullies there is high vulnerability of flood.
- Lack of pedestrian way which discourages walking and cycling, most of right of row is occupied by built-ups and informal trade, for this reason pedestrians are discouraged for walking and cycling.
- Potential site for city's image, as the area is the main route of the city proper and planned future developments will change the image of the city and attract investments.
- Its connectivity with neighboring cities increases the exchange of commodities.
- Presence of main streets that junctions different kebeles.
- The existence of high rise and medium multi-purpose buildings.
- Existence of main stream to discharge storm water from town.

3.4 Research Design

The research is descriptive in its nature as it attempts to identify the situation of street infrastructure challenges and prospects in the study area in order to inform relevant stakeholders in addressing the issue in an integrated manner for ensuring better welfare to urban dwellers and increasing productive efficiency in urban economic engagements. The study will use both qualitative and quantitative approaches.

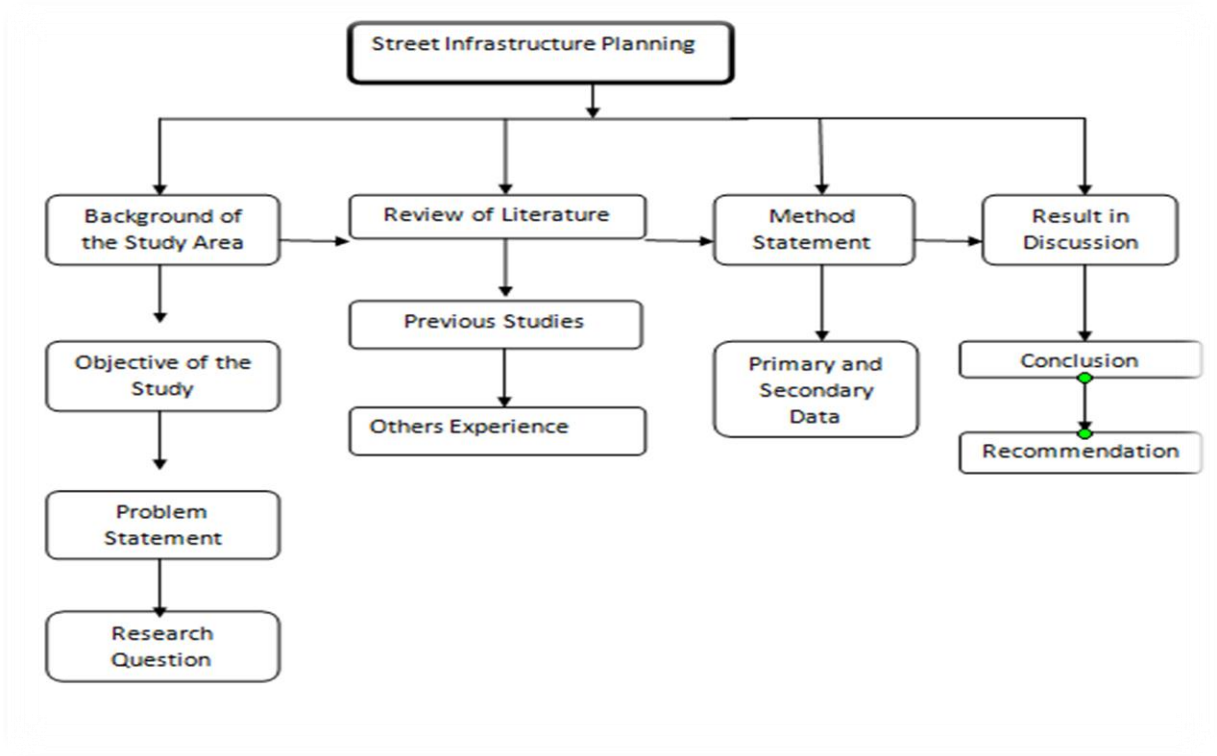


Figure 10: Research design

(Source: author)

3.5 Data Sources

The primary data was collected from residents around and by using direct observation, survey, focus group discussion and interview of municipal professionals. Secondary, data was also collected from existing documents from different places and organizations to get a better understanding about the challenges happened as a result of poor provisions of infrastructure planning.

3.6 Sampling Method/Technique

The study will use both probability and non-probability sampling method. The non-probability method of sampling is based on purposive (judgmental) sampling method in order to gather accurate and enough data that help full to the aim of the study from purposely predetermined and selected samples.

3.7 Method of Data Collection and Instrument

The study will use different types of data collection methods like questionnaire, interview, Focus Group Discussion and direct observation. These data collection methods and instruments will help the study to get concrete and useful data from the research subjects.

3.8 Variables of the Study

The independent variables are challenges to realize integrated street infrastructure and the dependent variables are proposed solutions that come after the identifying the independent variables.

3.9 Population of the Study and Sample Size

There is no clear cut number of population of the study area. The researcher however determines the sample size to make the data collection clear and easy. Small sample size of is determined because of the homogeneity of responses in order to avoid redundancy. A total of 73 persons were interviewed from different stake holders and residents based on their experience and involvement in the street infrastructure planning and development activities including households, city administration and Environmental Protection office.

Open-ended questions were used during the interviews to understand respondents' views about street infrastructure planning practice and its impact on the community and the city's image.

CHAPTER FOUR

4.0 DATA ANALYSIS AND DISCUSSION

This chapter focuses on data analysis and discussions based on the data collected from respondents. After gathering the necessary information from all respondents and source, the researcher analyzes the data by using descriptive and explanatory method of data analysis; including tabulation, percentage and graphs. Hence all data interpretation relayed on descriptive analysis. Finally conclusion was made accordingly.

Major types of services and function of improved street infrastructure

Improved street infrastructure is an infrastructure which fulfills the general standards of infrastructure planning and development. An improved street infrastructure gives various kinds of services and functions. It facilitates sustainable development and creates the feeling of living in an organic city for the residents. Sustainability of urban infrastructure and integration in planning and implementation of the infrastructure is a challenge in most of the urban centers.

4.1 Existing Street Network of the Area

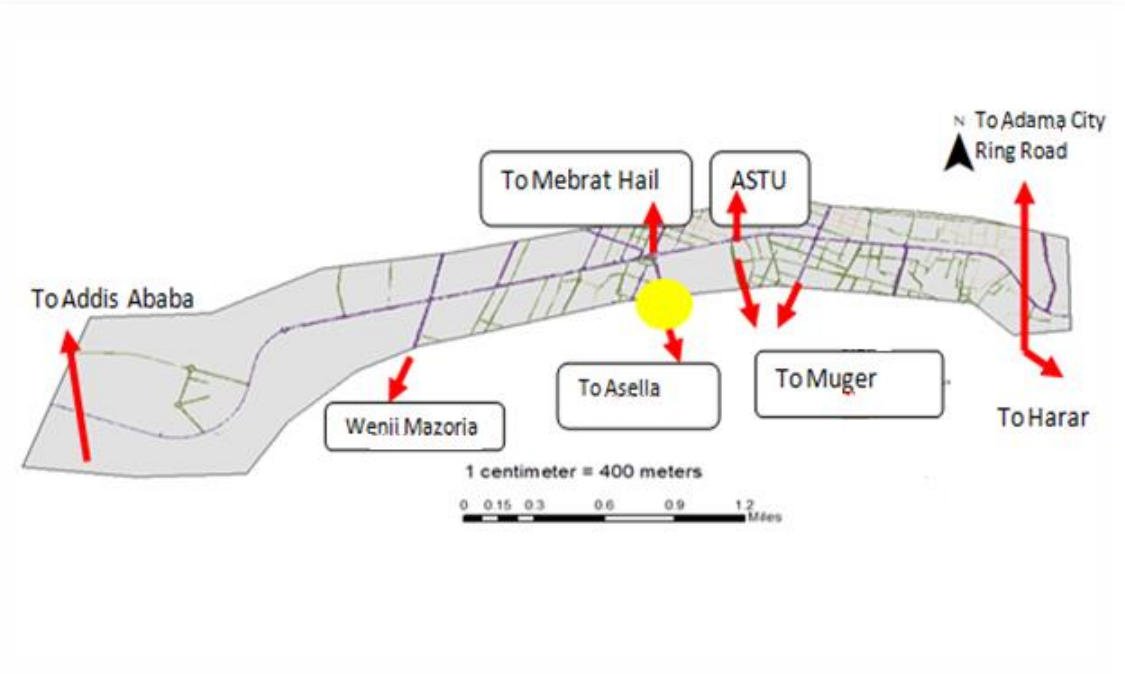


Figure 11: Existing street network of the site under the study

(Source: author)

4.2 Existing Street Junctions of an Area

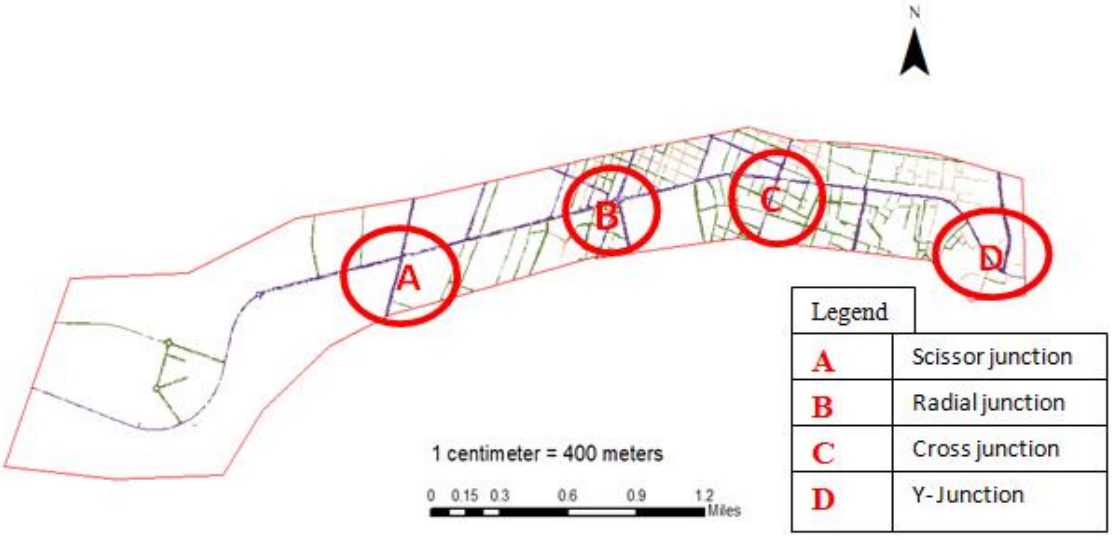


Figure 12: Existing street junction of the study area

(Source: author)

4.3 Physical Characteristics of the Area

Existing streets by Hierarchy

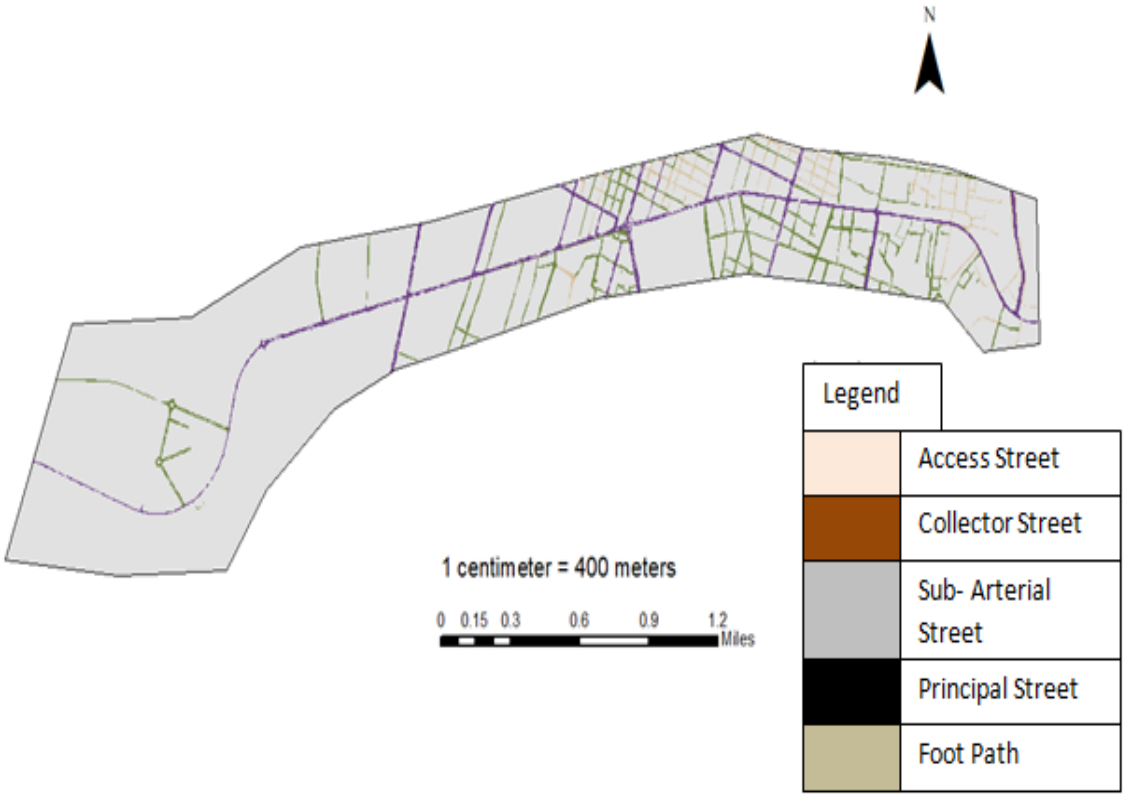


Figure 13**: Hierarchy of existing streets**

(Source: author)

Figure 14 : Physical characteristics

(Source: field survey)

4.4 Topography

In the study, topographic analysis is one of the major component used to identify the nature of the site. Figure 15: illustrates topography of the study site to provide the general information about the existing features.

Figure 15 : Topographic map of the study site

(Source: Areal image)

4.4.1 Slope Analysis

Topographic condition of the area can be illustrated in terms of slope analysis. Hence slopes can be classified according to the uses for which they are suitable. As it can be seen from the slope classification map, the slope of Adama town is largely dominated by a terrain with very flat plain to undulating steep slopes. Slope with less than 2% dominate in most parts of the study area. This indicates that the site under the study existed on the area where exposed to flood.

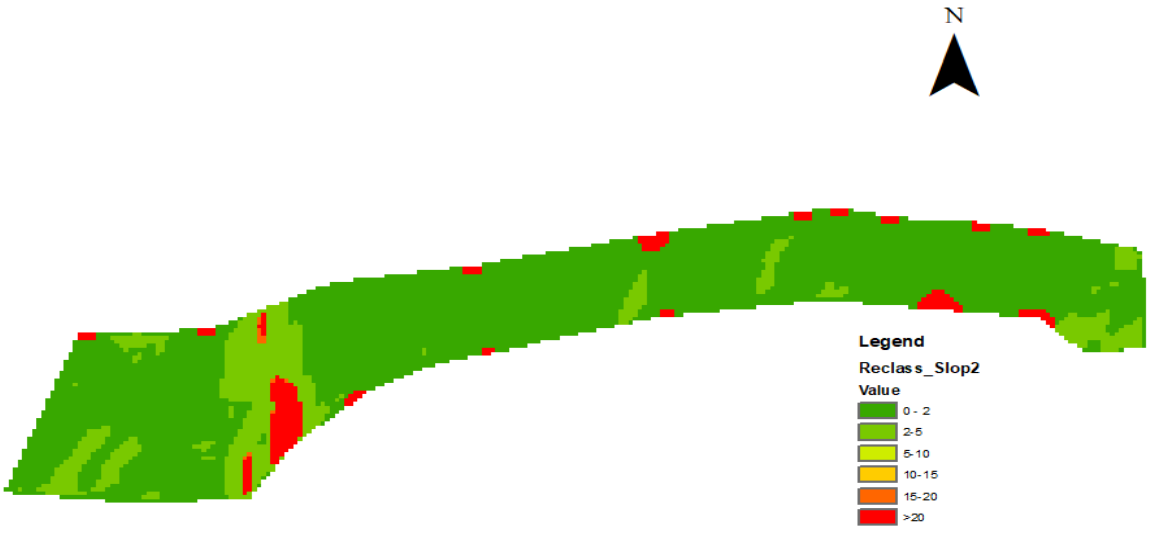


Figure 16: Slope analysis of the site under the study

(Source: Author)

Table 4: Slope analysis of the study area

	Value	Count	Pixel area	Area m2	Area in Ha	%
1	0-2	2633	839.838	2211294.26	221.129426	39.32198332
2	2-5	3001	839.838	2520354.75	252.035475	44.81780161
3	5-10	746	839.838	626519.376	62.6519376	11.1409797
4	10-15	182	839.838	152850.572	15.2850572	2.71804063
5	15-20	121	839.838	101620.435	10.1620435	1.807048986
6	>20	13	839.838	10917.898	1.0917898	0.194145759
	Total			**5623557.291**	**562.3557291**	**100**

(Source: Author)

4.5Existing Land Use of an Area

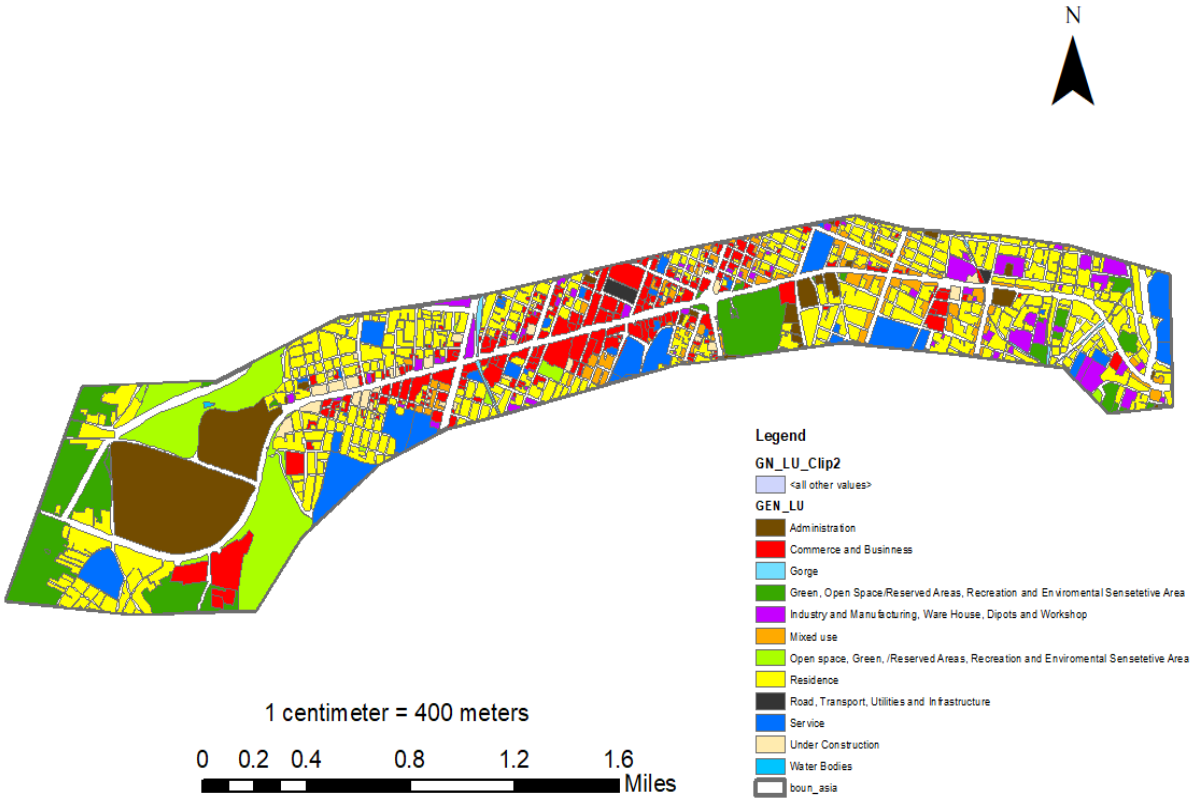


Figure 17: Existing land use of the study site

(Source: author)

4.6 Infrastructure

Inner city areas are the most economically vibrant part of cities in many countries. It is usually a place where different types of land uses exist together. In most cases inner cities have better infrastructural services than in other part of the city. However, mostly in third world countries inner cities have old aged infrastructure then calling for renovation. The same is true in the inner city of Adama. The structures are dilapidated; furthermore, there is a need to bring intervention and efficient land use.

Infrastructural services represent network and social infrastructure, like water supply, sanitation, electricity, streets and drainage; schools, health centers, market places etc.

4.6.1 Circulation and Mobility

The site is relatively better located and furnished with major transportation corridor and communication infrastructure, connecting it to the surrounding economic centers, which gives a better opportunity for urban service provision. In addition, there is a potential for linking easily the project site with the public transport services; possibly with a good opportunity to model transit-oriented development that provides commercial, housing, employment, parks and civic uses within walking distance.

4.6.2 Existing Street Network

- The existing street network lacks standard width, pedestrian walkway, parking, taxi and bus stops, roundabout, drainage and street furniture especially at the central area.
- The existing situation results in traffic conflicts between different modes/movement conditions on the street passing through the area and creates high traffic pressure, congestion and accidents.
- Very small and chaotic street block arrangements,
- Poor street hierarchy, the main street has relatively median and but not defined lanes and it has no proper junctions.
- Local Streets are connected to principal arterial streets within short distances of street blocks.
- Inadequate setbacks

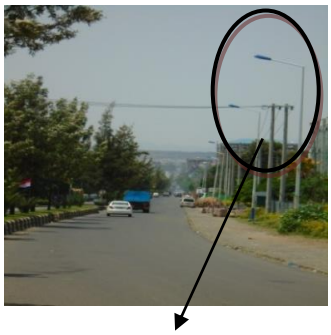
- Earth street cover and the local streets are exposed to erosion and inaccessible for vehicle, even if its width permits.

4.7 Observation

4.7.1 Types of Infrastructures Observed

The types of infrastructures observed around the study area is14 m wide Asphalt street, 2 m wide median greenery, in some parts 3-4 m wide walk way and on the other side less than 1 m wide walkways, partially opened, covered and clogged storm water drainage, partially functional street light; on street parking, no set back of existing buildings, street vendor, temporary shades, release of liquid waste to storm water drainage and occupancy of buildings on storm water drainage.

Based on information gathered through observation most of the street infrastructures are underutilized and not properly function to deliver the expected output.



Un-functional street light

Un-Covered drainage

Inconvenient shoulders of road

Gravel road junction to Kidane - Mihiret Church

Un-functional traffic light

Potholes happened as a result of poor drainage system

Figure 18 : Existing street infrastructures

(Source: Field survey)

4.8 Profile of Respondents

The respondents for the study were selected randomly from different governmental, non-governmental organizations and community elders. Of the 85 questionnaires distributed to the sample respondents, 73 were received back. The detail about the percentage and number of respondents is illustrated in figure 19.

4.8.1 Gender Classification of Respondents

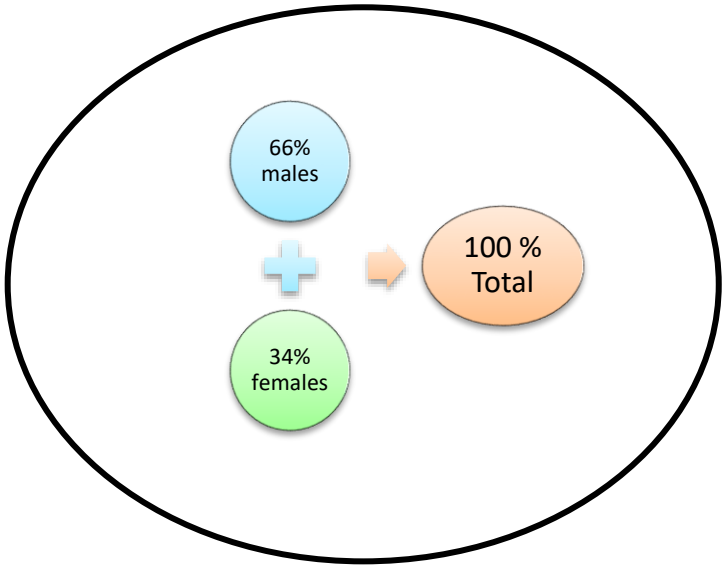


Figure 19: Gender Classification

(Source: field survey)

4.8.2 Age Classification of Respondents

Respondents profile indicates, from the sample respondents 44% were aged between 24-40, 27% were aged between 41-50, 29% were aged above 50. This shows that most of respondents are aged between 24-40.

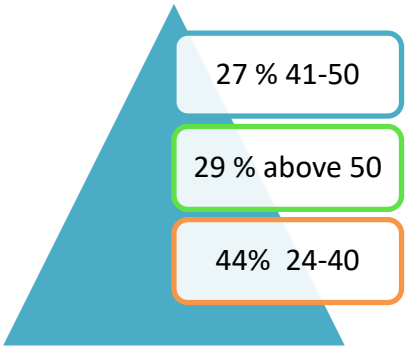


Figure 20: Age classification of respondents

(Source: Field survey)

4.8.3 Residential Status

Residential status shown in Figure 20 is done in order to see how much of residents were from Adama and how much of them know and were exposed to the problem the researcher is dealing with.

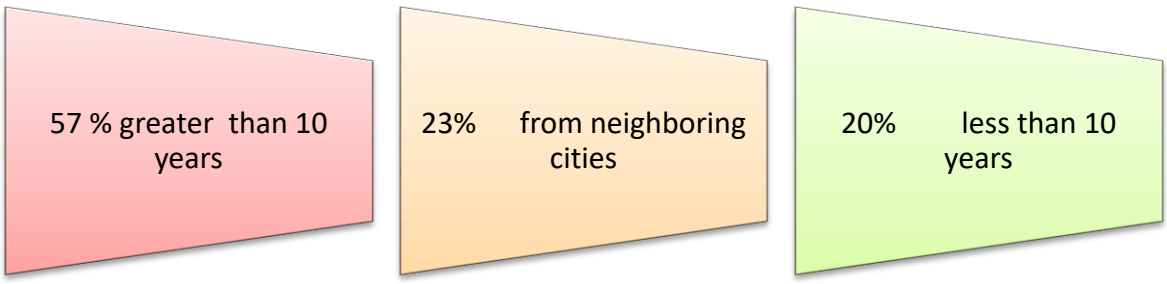


Figure 21: Residential status of respondents

(Source: Field survey)

This shows that 57% of residents are living more than 10 years in Adama, 23% are residents from neighboring towns and 29% are living less than 10 years in the town.

4.8.4 Educational Status of Respondents

Educational Status is one of the most crucial aspects of this paper because; responses given by highly educated personnel will be based on scientific reasoning and guides to set logical conclusion about the type, function, effectiveness and its adverse impact of underutilization of street infrastructures in the study area.

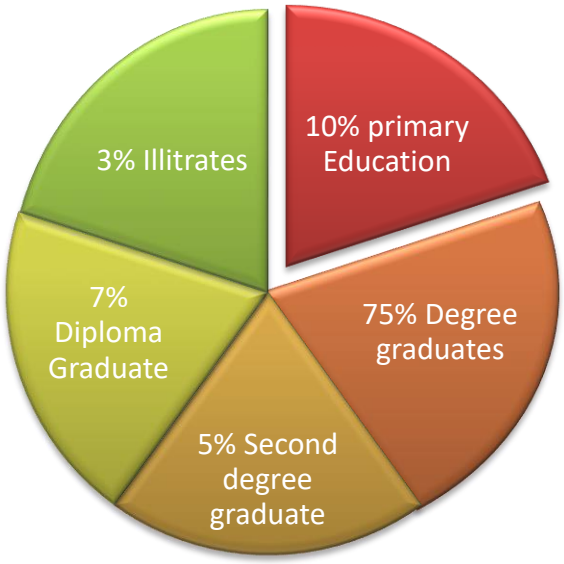


Figure 22: Education status of respondents

(Source: field survey)

From figure 22 the researcher concludes responses are based on personal experience and based on skills acquired through education.

4.9 Previous Studies and Their Assumptions

1. **Master Plan Of 1971**

   Assumptions

The general pattern of these framing roads depicts that major corridors are radiating from the Finfinne-Dire Dawa road. This also implies the need for linkage between the radiating roads with ring type road, especially, on the southern part of the city.

The length of this road which requires asphalt cover and that serves both as an outlet and for urban mobility purposes is 2.5 km which is an areas from Awash Hotel to EEPCO sub-

station site. The width of this road varies between 20 and 50 m, where most part is found with 25 to 30m width. The types of development, which narrowed the 1971 Master plan proposal (50 m width), are informal settlements and the part of military barrack fenced by hedges.

Remark

The assumptions were very essential for a city's future development, but there was no clear cut implementation strategy to guide the mentioned points.

2. **2004 Structural Plan**

Assumptions

- Widening of Finfinne –Dire Dawa Road
- Institutional reforms for the municipality (better organization and capacity)
- Improved maintenance administration and works.

Remark

Weakness of the 2004 Adama Structural plan

- Lack of recommendations on institutional problems.
- Priorities and identification of strategic problems and corresponding action were not treated.
- Regulatory and standard aspects of roads were not treated.
- Traffic management, road safety, issues of transport, etc. were not studied. Is it necessary?
- Issues related with street infrastructures and amenities are not treated.
- The relationship between green and grey green infrastructure around streets are not well defined.
- The concept of pedestrianism and pedestrian's safety and security issue were given less attention
- there was not in depth analysis about integration between land use and transport

3. **Studies conducted by city administration in collaboration with Adama science and Technology University and other institutions**

Major alternatives taken from previous studies

Key informants also asked about kinds of interventions proposed by the city and responded as follows. There were uneven distribution of carriage way throughout the site which is created due to many reasons. the site is also affected by storm during rainy seasons because there is high discharge and velocity which is very difficult to be controlled with existing structures as they are clogged and occupied by private properties, in some cases most of private buildings release sewer from their compound and connect it to storm water drainage.

An intervention mechanism was set as long term and short term solution.

Short Term Solution

The short term solution is pre cleaning works of channels, disconnecting sewer lines from channels, providing spaces for all utility lines to be accessed.

Long Term Solutions

The long term solution was widening the right of way (ROW) to accommodate standard street cross sections, construction of large retaining walls to overcome overflow of discharges, planting adequate greeneries to create a feeling of organic city and redesigning both roundabouts.

Remark

- There are no clear cut directions given to implement by concerned body.
- lack of budget
- lack of institutional capacity to implement
- high rate of officials turn over

4.10 Implementation Status of Planned Intervention

Respondents from key informants argue that only 10-15% of planned intervention methods are implemented and the rest are waiting for committed administrators and community.

Figure 23: Implementation status of planned activities

(Source: Field survey**)**

This analysis shows more than 85% of planned activities are not realized and it indicates the need for clear and workable implementation strategy.

4.10.1 Current Status of Street Infrastructure

Questions raised on the current status of street infrastructures have got a reply from 73 respondents, out of which 55 (75.33%) replied as the street lacks public peace: discourages pedestrianism: lacks the meaning and role of street that provides link between buildings, both within the street. They also replied as the street lacks to facilitate the movement of people as pedestrian: as it lacks inclusiveness (handy caped): absence of street furniture, bike lanes, curb, gutter drainages shelter and bus stops. 10 (13.7%) replied as the street lacks safety and security for the users, as on street parking lowers the movement and circulation, some structures like round about becomes cause of conjunction and accident, 8 (10.97%) replied as the street lacks green infrastructures.

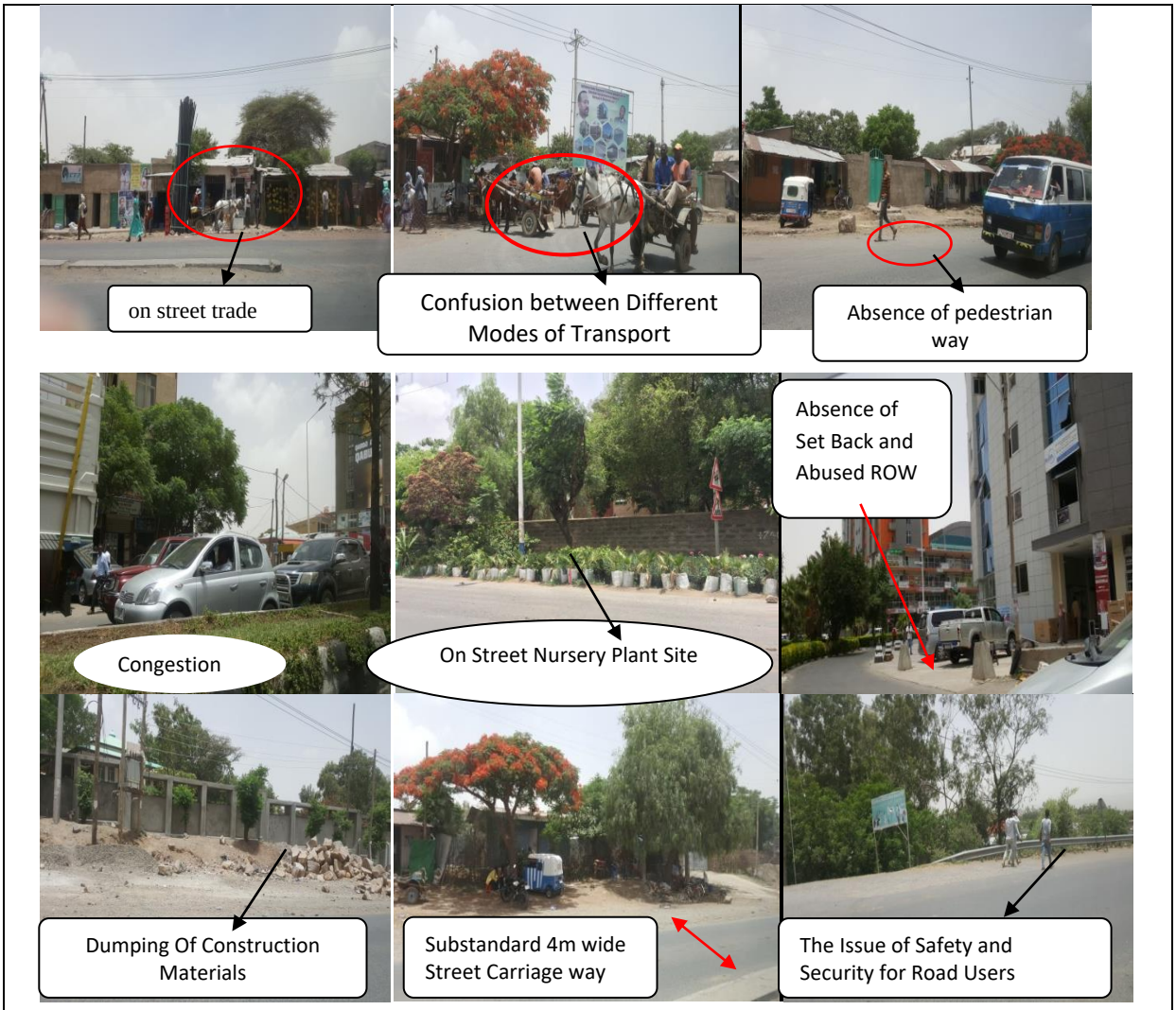


Figure 24: Current status of street infrastructure in the study area

(Source: author)

Table 5: Current status of street infrastructure

SN	Responses	No of Respondents	In Percentage
1	street lacks public peace, discourages pedestrianism, lacks the meaning and role of street that provides link between buildings, both within the street and as a link it didn't facilitate the movement of people as pedestrian or within vehicles and also the movement of goods to sustain the wider market, and also they respond as it lacks inclusiveness (handy caped), no street furniture, bike lanes, curb, gutter drainages shelter and bus stops.	55	75.33
2	Street lacks safety and security for the users, and also as on street parking lowers the movement and circulation, some structures like round about becomes cause of conjunction and accident.	10	13.7
3	Street lacks green infrastructures.	8	10.97

(Source: Author)

This analysis shows that nearly 98% of the respondents were of the opinion that the current status of the street is poor and substandard.

4.10.2 The Need for Planning Intervention

Table 6: The need for planning intervention

SN	Responses	No of respondents	percentage
1	Needs planning intervention	70	96
2	No idea	3	4

(Source: Field survey)

The analysis shows 96% of respondents are of the opinion of the need for planning interventions.

4.10.3 Observation from Urban Planning and Urban Design Elements and Principles.

52 (71.2 %) respondents addressed as the street lacks pedestrian way, standard side and median greenery, lack of variety of activities enjoyed by pedestrians. The other 15 (20.5%) says the street is not robust ,not accessible for all, no bus stops, from planning point of view not change accommodative, lacks urban design details. The rest 6 (8.30%) says no light and illumination during night, no drainage, not accessible, not permeable and not furnished.

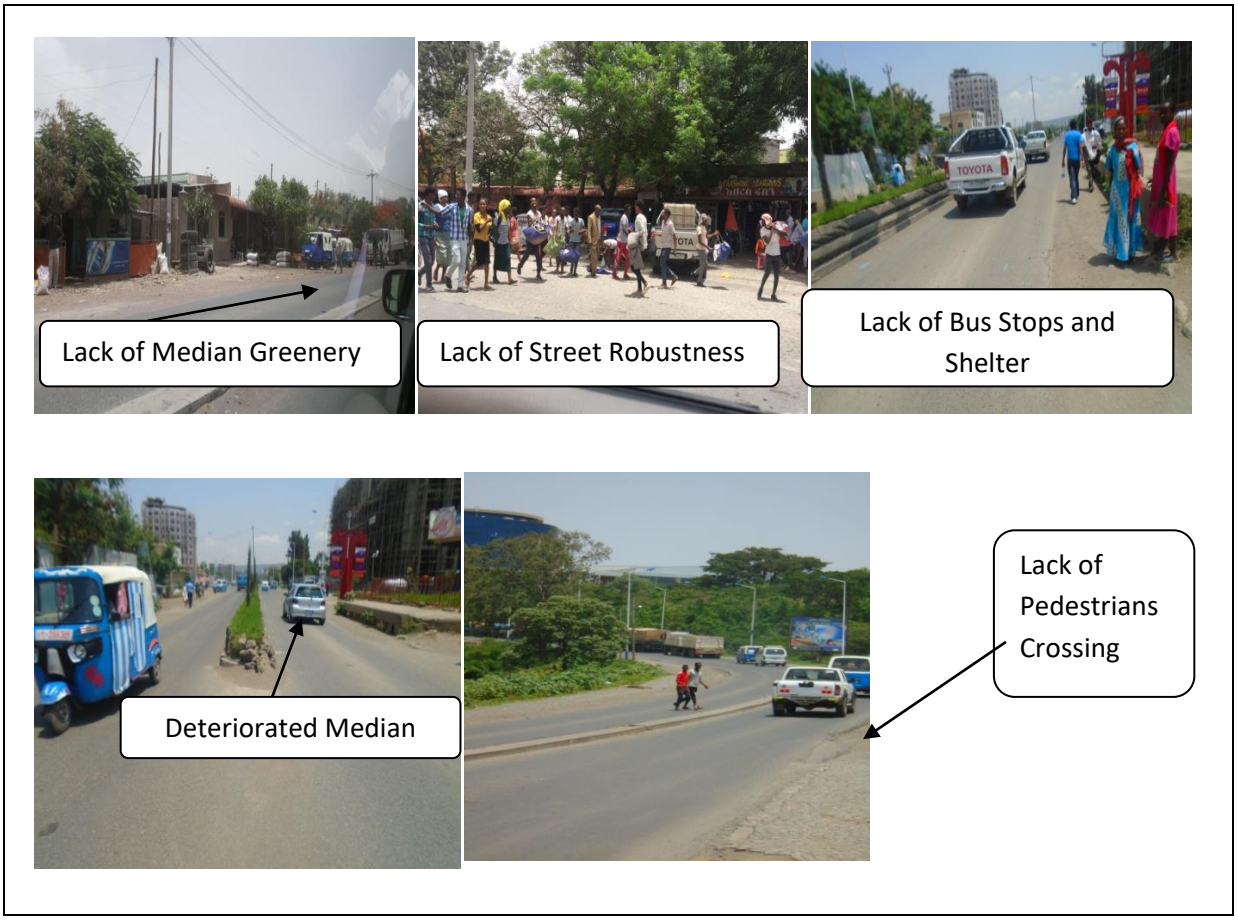


Figure 25: Current status of street infrastructure observed on the study area

(Source: Own data)

Table 7: Responses on current status of street infrastructure

SN	Responses	No of Respondents	In Percentage
1	street lacks pedestrian way, standard side and median greenery, lack of variety of activities enjoyed by pedestrians	52	71.2
2	street is not robust ,not accessible for all, no bus stops, from planning point of view not change accommodative, lacks urban design details	15	20.5
3	No light and illumination during night, no drainage, not accessible, permeable and furnished at scale of pedestrians, lacks corridor planning, not well planned to accommodate street parameters.	6	8.3

(Source: author)

The analysis shows more than 95% of respondents agree as the street lacks major principles and elements of urban design and urban planning.

4.10.4 Impact of Improper Utilization of Street Infrastructures

Respondents were asked to reveal their feelings about the effect of improper utilization of street development on public, private and community. 19 (26%) argue on pedestrians inconvenience while using the street because it lacks inherent feelings safety and social bond and lacks safety and security for private developers and community, 29 (39.7%) responded as it lowers the aesthetics of the city, where as 12 (16.4%) argue as it lowers the functionality and serviceability of the street, 11 (15%) responds the clogging o f drainages which results in damage of property by natural hazards like flooding, traffic jam and over utilization of streets for parking.

Table 8: Response on impact of improper utilization of street infrastructure

SN	Responses	No of Respondents	In Percent
1	Pedestrians inconvenience while using the street because it lacks inherent feelings safety and social bond and lacks safety and security for private developers and community,	19	26%
2	lowers the functionality and serviceability of the street	12	16.4%
3	Clogging of drainages which results in damage of property by natural hazards like flooding, traffic jam and over utilization of streets for parking.	11	15%

Man holes closed for private purpose

On Street Parking in front of buildings

Figure 26: Impact of improper utilization of street infrastructure on the area

(Source: Own data)

The Analysis clearly shows abused street infrastructures by private developers and is effect on community in general.

4.10.5 Management of Natural Hazards

Another question was raised on the status of management of natural hazards like flooding. It is replied by 42 (57.5%) respondents as there is a high flood which comes from old rail

way that causes flood and damage properties of private investors and public during rainy season, drainage system around the study area clogged and some hotels connect their sewers system which makes the problem complicated. Un-covered storm water drainage ditches discomforts pedestrians and become a destiny of solid waste disposal and also they addressed its difficulty to control those natural hazards because the poor drainage system as a result of poor street infrastructure planning. 10 (13.7%) replied absence of drainage network maser plan to guide storms to their appropriate destiny. 21 (28.76%) replied about the negligent administrative officials and decision makers toward maintaining the structure plan leads plan violation which resulted in prolonged damages by flooding.

Table 9: Response on management of natural hazards

SN	Responses	Respondents Number	%
1	High flood which comes from old rail way that causes flood and damage properties of private investors and public during rainy season, Drainage system around the study area clogged and some hotels connect their sewers system which makes the problem complicated. Un-covered storm water drainage ditches discomforts pedestrians and become a destiny of solid waste disposal	42	57.5%
2	Absence of drainage network maser plan to guide storms to their appropriate destiny.	10	13.7%
3	Negligent administrative officials and decision makers toward maintaining the structure plan leads plan violation which resulted in prolonged damages by flooding.	21	28.76%

Figure 27: Management of natural hazards around the study area

(Source: Field survey)

This indicates more than 90 % of the respondents have known about the seriousness of the problem and their suggestion will be supportive for well-organized conclusion of street infrastructure problem of the study area.

4.11 Trends of Integrated Infrastructure Planning

The level of coordination among the service giver institutions was one of the areas of analysis in the survey. Accordingly, the respondents were asked to respond on their evaluation on the coordination level. The majority of the respondents perceived that there is no integrated infrastructure planning and implementation within all institutions.

68 (93.15%) respondents address all service giver institutions that work on infrastructure construction and the city administration plan independently and implements independently. 10 (13.69%) replied as the level of integration is very poor and lack of commitment of concerned bodies to run projects by co-operation of institutions to minimize extra cost.

Table 10: Response on trends of integrated infrastructure planning

SN	Responses	Respondents Number	%
1	No integrated infrastructure planning and implementation within all institutions.	68	93.15%
2	Level of integration is very poor and lack of commitment of concerned bodies to run projects by co-operation of institutions to minimize extra cost.	10	13.69%

(Source: author)

The analysis indicates poor integration of institutions that give services and the need for developing system of working together to realize the expected outputs to be delivered for community.

4.12 Green Infrastructure Provision

Respondents also asked about access to green infrastructure round the study area and reacted as follows. 62 (84.9%) of respondents address negligence of decision makers, lack of priority to green space, ownership problem (lack of site plan) ,the rest 11 (15.06%) replied lack of framework, substandard greenery plantation on medians and in some part of walk ways.

Table 11: Green infrastructure provision

SN	Responses	Respondents Number	%
1	Negligence of decision makers, lack of priority to green space, ownership problem (lack of site plan)	62	84.9%
2	Lack of frame work, substandard greenery plantation on medians and in some part of walk ways.	11	15.06%

(Source: author)

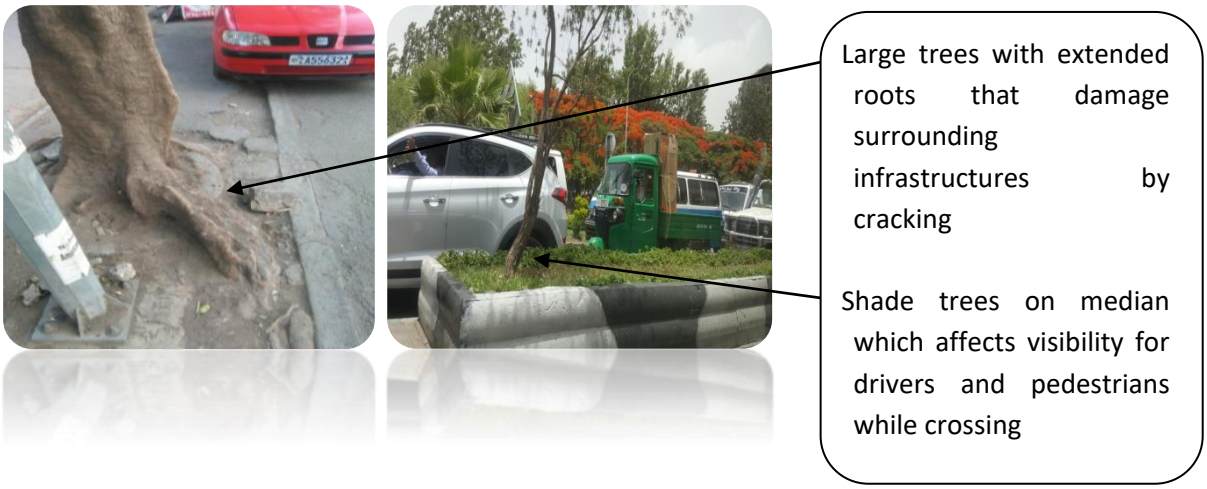


Figure 28: Green infrastructure provision in the case site

(Source: author)

This indicates all respondents agreed as there is a lack of green infrastructure provision in the area.

4.13 Challenges of Roundabout around Derartu Square and Abdisa Aaga

Respondents were further requested to evaluate the challenges of the two roundabouts and replied as follows.23 (31.5%) replied as both roundabout lack inadequate provision for pedestrians, Poor lane marking configuration, Poor destination signing for drivers, 38 (35%) argue on Poor recognition of central island, poor recognition of central island, Visibility Restricted by vegetation, poor street furniture location and provision, 12 (16.4%) argued that on roundabout were not treated well during design, inadequate deflection of roundabout, poor lightning, lack of building setback.

Table 12: Responses on challenges of round about around Derartu Square and Abdisa Aaga

SN	Responses	Respondents Number	%
1	Inadequate provision for pedestrians, Poor lane marking configuration, Poor destination signing for drivers	23	31.5%

2	Poor recognition of central island, Poor recognition of central island, Visibility Restricted by vegetation, Poor street furniture location and provision	38	35%
3	Round about didn't treated well during design, Inadequate deflection of roundabout, Poor lightning ,Lack of building setback	12	16.4%

(Source: author)

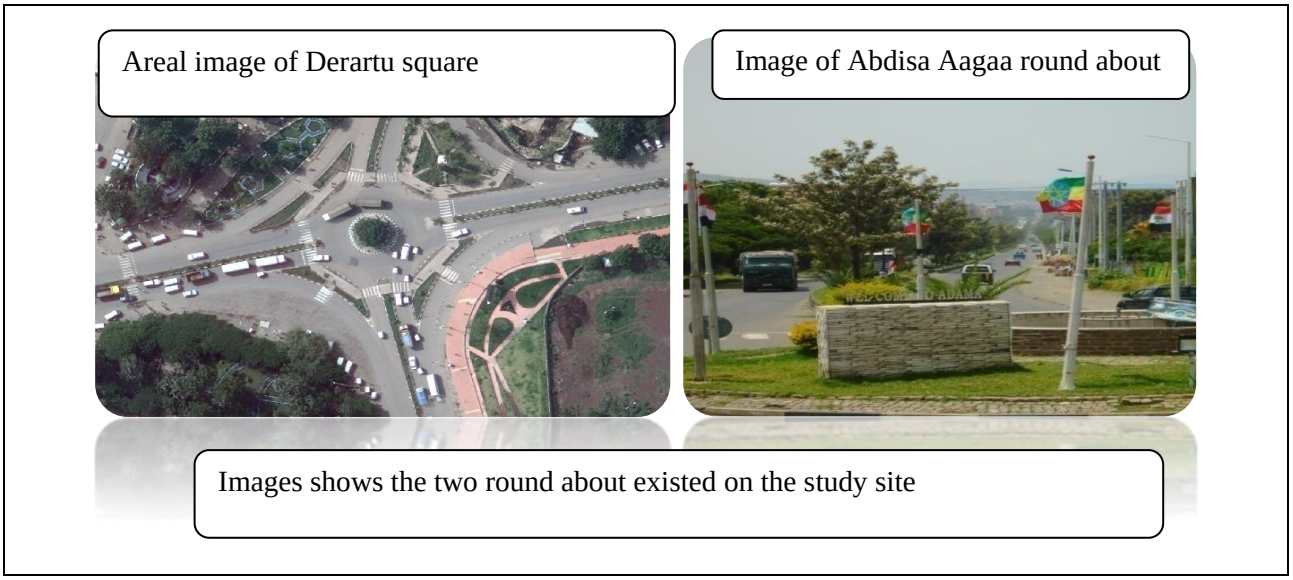


Figure 29: Existing situation of Derartu Square and Abdisa Agaa roundabout

(Source: Field data)

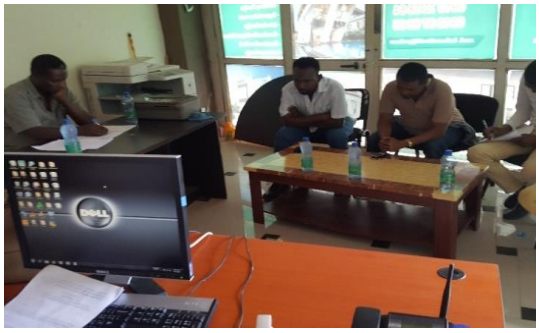


Figure 30: Respondents attended focus group discussion

(Source: Own data)

The statement below is a detailed explanation acquired through interview, questionnaires' and focus group discussion.

I. Inadequate provision for pedestrians

The roundabout junction tend to be unfriendly to pedestrians because of its free flowing nature and the fact that crossing points generally need to be further from the intersection than for conventional intersections.

Inadequate pedestrian access at Derartu square and Abdisa Aaga roundabout lead to:

- Accidents resulting from poorly sited crossing locations.
- Misuse of the existing pedestrian routes without making suitable alternative provision.
- Poor inter-visibility with approaching drivers.
- Inadequate stopping sight distance for motorists.
- Crossing points not being located on pedestrian desired routes.
- Poor design or lack of provision of parking facilities and over utilizing of on road parking.
- Central islands of the roundabout are accessed by pedestrians.

Providing adequate facilities for pedestrians at roundabout junction requires careful attention to the needs of all road users. Facilities must be provided as close as possible to the desired pedestrian paths to ensure their effectiveness.

I. Poor lane marking configuration

Poor or insufficient road markings confuse road users and provide little guidance for the driver approaching and travelling through the roundabout.

Inadequate or poor road markings at the Derartu square and Abdisa Aaga roundabout leads:

- Motorists into unsafe situations and confusions due to Old signs and markings.
- Reduce capacity of the roundabout to handle the intended traffic volumes.
- Increase speeds through the roundabout.

II. Poor destination signing for drivers

Due to inadequate provision of good signage, Derartu square and Abdisa Aaga roundabout do not allow users to plan their route in advance of the roundabout, to adjust their speed, and select the appropriate lane from which to enter the roundabout. Therefore, inadequate or inappropriately located advance warning and directional signage lead the users of the roundabout to:

- Confusion for unfamiliar drivers seeking a particular location.
- The inability of the motorists to anticipate the type of junction ahead.
- Reduced driver's vision.
- Last-minute or unexpected lane changing when destination information is provided too late.

III. Poor recognition of central island

Drivers unfamiliar with the intersection require appropriate information and guidance to enable the correct vehicle paths to be taken. From my site visit the central island within a roundabout is not carefully signed; so improving its visibility is required. Therefore this poor central island recognition leads to drivers colliding with or driving through the central island.

Lack of central island recognition leads to:

- Drivers losing control because of failure to see Central Island.
- Accidents due to sudden braking.
- Inability to determine appropriate roundabout speeds leading in turn to accidents resulting from failure to give way.

IV. Visibility Restricted by vegetation (Derartu Square)

There is visibility problem caused by vegetation and masonry. This causes the entering driver to delay on entering the circulating traffic and affecting the capacities of the roundabout. Inadequate or obstructed lines of sight can result in drivers being unable to identify hazards as they approach and enter the roundabout:

- View is obstructed by signs/vegetation creating blind spots for drivers.
- Efficiency of the roundabout is affected because of extra delays associated with poor visibility.
- Signs and vegetation hide smaller and/ or slower moving road-users such as pedestrians or cyclists.

V. Poor street furniture location and provision

In both roundabouts there is poor and/or inappropriate provision and location of street furniture which lead:

- Drivers hitting obstructions.
- Poor inter-visibility with other road users.

VI. Inadequate deflection of roundabout

Inadequate deflection on approaches result in higher approach speeds and this lead to:

- Failure to give way to vehicles already on the roundabout.
- Collisions when vehicles brake suddenly.
- Loss of control accidents within the area of the roundabout.

VII. Poor lightning

There is poor and/or inappropriate lighting at the roundabout junction that lead drivers entering the intersection with inadequate information resulting:

- Confusion, causing emergency braking and/or collision
- Loss of control night-time accidents
- Delays due to poor guidance to motorist

VIII. Lack of building setback

- Lack of building setbacks which result uncomfortable situation even to walk.
- Lack of parking facilities for the buildings and over utilizing of on road parking,

The analysis drawn from answers of respondents indicates both roundabout are bottlenecked with many challenges and it indicated the need for detail analysis and redesign.

4.14 Challenges to Ensure Well Planned Street Infrastructure

Respondents on focus group discussion argue that, poor planning trend and design that didn't consider link of street to facilitate the movement of people as pedestrians or within vehicle and also the movement of goods to sustain the wider market, the replacement of the street or public spaces by large buildings blocks in sea of amorous or un-owned space, poor part of the design that ignores the social part of a street, topographic challenges, lack of community participation, less attention given by concerned body.

Table 13: Responses on challenges to ensure well planned street infrastructure

SN	Responses	No of Respondents	In Percent
1	Poor planning trend and design that didn't consider link of street to facilitate the moment of people as pedestrians or within vehicle and also the moment of goods to sustain the wider market, the replacement of the street or public spaces by large buildings blocks in sea of amorous or un-owned space	12	100%
2	Poor part of the design that ignores the social part of a street, topographic challenges		
3	Lack of community participation, less attention given by concerned body.		

The analysis indicates 100% of respondents agree on poor part of designing and planning trends that ignores social part of the street.

From field observation and on site interview on the challenges most frequently happened to insure planned street infrastructure to reality

All respondents reacted well by listing the challenges that frequently happened to insure well planned street infrastructure. 35 (47.9%) respondents suggest that financial constraint is the major challenge in order to realize structure plan and widening the street there are enormous amount of building structures. this in turn incurs high compensation costs which may become double or triple of realization project on municipality ,10 (13.7%) argue on Exposure to flood during rainy season – lack of drainage network plan of the city leads inefficient storm water mitigation program,5 (6.58%)argue on Poor management – administrative part of the city shows low commitment toward laying bases for any infrastructures construction and expansion,12 (16.4%)suggests Transportation problem- due to small sized vehicular way and large number of vehicles traffic congestion ,lack of parking area are the major ones,3 (4.47%) argue on Setback issue –Poor set back practice makes the area complicated,8 (10.95%)responds to poor provisions infrastructures and utilities.

Table 14: Responses on major challenges to insure planned street infrastructure to reality

SN	Responses	No of Respondents	In Percent
1	Financial constraint	35	47.9%
2	Exposure to flood during rainy season	10	13.7%
3	Poor management	5	6.58%
4	Transportation problem	12	16.4%
5	Set back	3	4.47%
6	poor provisions infrastructures and utilities	8	10.95%

The response shows a barrier that hinders the realization of planned activities within their planned time.

4.15 SWOT Analysis

Strength

- Existence of main street junctions that connects Addis Ababa and Harar and Assella.
- Presence of main streets that connects kebele 12 (ganda Gadaa), 08 (ganda Odaa) and 10 (ganda Biqqa).
- Existence of some infrastructures.
- Existence of main stream to discharge storm water from the town.

Weakness

The major weakness of our site can be summarized as follows:

- Mismatch between master plan of the city and the existing condition (the size of ROW indicated on master plan was 45 m but the existing is only an average of 30-35 m).
- Indistinguishable amenity and pedestrian zones. Lack of setback of buildings from public properties.
- Weak infrastructure integration along the main streets.
- Existence of informal settlements in the form of trade houses.
- Lack of stream management.
- Lack of Signage and street furniture and invisible pedestrians crossing.
- Inadequate and uncomfortable pedestrian walkway
- Accessibility and permeability problems
- Lack of standard and sufficient parking areas
- Vertical and horizontal clearance problems, especially on electric lines.
- Drainage problems such as open manholes, manholes filled with garbage's , etc
- Unplanned drainage network and clogged drainage lines
- Existence of roundabout which is cause of traffic jam
- Abused pedestrian way for parking, informal trade and informal settlement
- The mismatch of main street capacity and traffic flow
- The increasing trend of traffic congestion,

- Lack of dedicated bus and bicycle lanes
- Lack of parking facilities and over utilizing of on street parking
- Lack of public and freight transport terminals with necessary facilities
- Aesthetically and functionally unpleasant median curb stone
- Lack of sufficient greenery and plantation from aesthetics and environmental protection point of view
- No standardized sewerage and drainage system.

Opportunity

- Connection with many major streets
- No obstruction within 30m width
- Potential area to build city's image
- The current support and willingness of the government policy towards redevelopment of inner city areas.

Threat

- Existence of privately owned high rise buildings
- High compensation cost
- High reconstruction work

CHAPTER FIVE

5.0 DESIGN SOLUTIONS

In this chapter the researcher proposes possible designs for problems discussed in chapter four. The main goal of the research is creating active streets with its full package infrastructure. From the above detail analysis of the problems, it can be concluded that the existing roadway which is from 4-7 m width in one direction does not match with the city's development requirement and also it can't accommodate high traffic volume which resulted from the increased import and export business. The roadway also lack proper drainage system and crossings that accommodate the flood generated from the city.

While investigating the problems the researcher found the possibilities to upgrade the street by increasing the roadway with the minimum 30 m width taking and considering the existing right of ways that can accommodate 7 m carriage way (two lanes), 3m pedestrian walkway in both directions and 2 m median, 3 m bicycle lane, 1m greenery,3m walk way. During investigation the existing right of way is identified that it ranges from 30 to 40m along the stretches. In addition, the offset of existing buildings along road corridor are tolerable range to upgrade roadway width.

The following statements shows key issues formulated from the combined SWOT analysis:

- **Safety and security:**
    - Reducing opportunities for criminal activities, especially in public spaces, for instance through the use of the principles of crime prevention through environmental design (CPTED).
    - Reducing exposure to environmental health risks and the risks of injury, and creating safe conditions on streets and sidewalks.
- **Integrated street infrastructure:**
    - It insures transport oriented development through efficient linkages and networks by integrating all street components as per the standard.

- **Pedestrian friendly:**
  - Providing opportunities for residents to improve their physical and mental health, for instance by creating an environment that encourages walking and the use of non-motorized modes of transport.
  - Social interactions needs to walk and the presence of people, city pedestrian ways are the specific areas of this order.
- **Networked:**
  - Interconnected street that disperses traffic and eases walking.
  - A hierarchy of narrow streets, boulevards, and alleys.
  - High quality pedestrian network and public realm makes walking pleasurable.
- **Environmentally sustainable:**
  - Minimal environmental impact of development and its operations.
  - Eco-friendly technologies, respect for ecology and value of natural systems.
  - More walking, less driving.
- **Well Furnished**: the ease of availability of street furniture and amenities, greeneries, utilities and pedestrian crossings along the street.
- **Inclusiveness:** creating inclusive street by providing street details that can be accessible by everyone.
- **Convenience:**
  - Providing an interconnected network of streets that provide people with a choice of routes that are safe, efficient and pleasant to use whether they are walking, cycling or driving.
  - Creating permeable streets by providing frequent connections between existing and new streets and pathways, and
  - Linking social facilities with movement systems, so that people can walk, cycle and use different transport modes to access economic opportunities, community, education and health-care facilities, commercial and entertainment areas, open spaces, places of recreation etc.
- **Economic opportunities:**
  - Support local economic activity by attracting outsiders and city dwellers, by providing efficient transportation and movement systems.

- **Aesthetics and character:**
  - Acknowledge the local context and identify features that could be incorporated into a development to create a distinct character or identity.
  - Improving Open Space: Recognize traditional, cultural or religious views and customs and sensitively incorporate places of significance, natural and cultural assets and heritage sites into a development where appropriate.
  - Integrating Land Use and Transport: creating strong bond to better integrate land use and transport planning.
- **Providing Infrastructure**: to provide a modern infrastructure base to support the areas' economic development and to attract businesses
- **Nodal development**: points of intense, activity, focal points, intersections.

Nodal development concept involves creating a center that serves as an iconic element by describing the culture, character, and socioeconomic values of the city. The researcher proposes iconic node around Derartu square by re-designing the roundabout and the surrounding by providing bicycle and pedestrian amenities such as sidewalks, visible crossways, streetscape improvements, and street furniture. Nodal development can enhance streets to be inclusive and unifying development, making it easier to achieve consistent design themes. Safety is also improved by concentrating access points within nodes and limiting them along corridors to minimize potential conflict points.

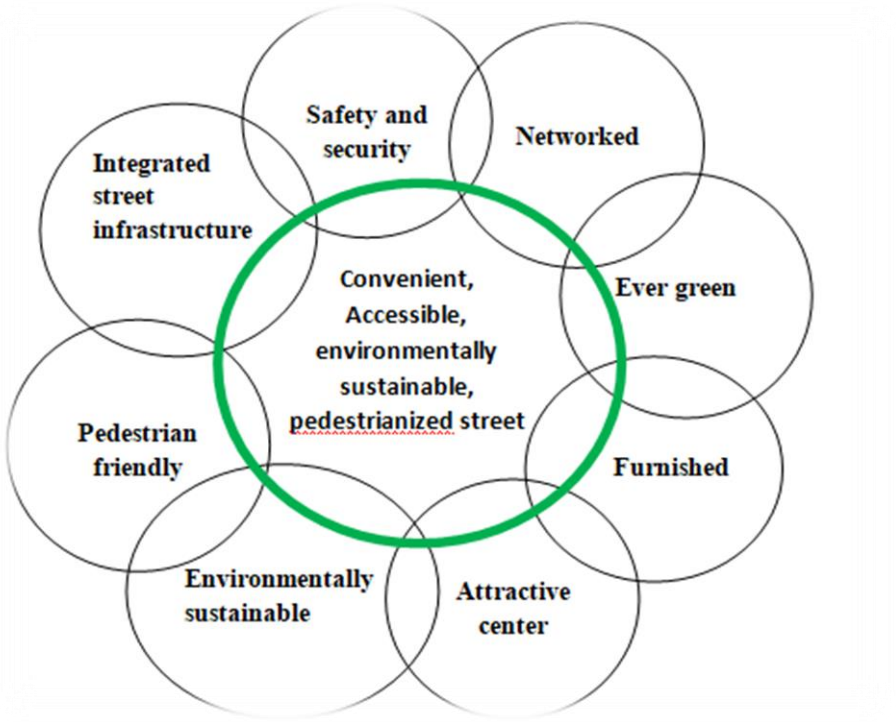


Figure 31: Concept diagram 1

(Source: Author)

5.1 Concept Development and Programs

5.1.1 The Proposed Development Framework

The site from Adama Town Ring Road to Kidane-Mihiret Church through Derartu Square is bounded by a collection of considerable old infrastructure development projects. In line with these, a broader scale for reference is established in a series of plan objectives that set an initial guideline to provide a framework for street infrastructure planning.

A component of street infrastructure considers the form, proportion, network, junction, parking, amenities, utility line and green infrastructure development along the street. Each component has considerably different demands and impacts on the project. The plan has to give due consideration for the smooth connectivity of the project site with the rest of the city to bring harmonized movement of pedestrians and vehicles.

Generally, the concept considers maintaining and re-designing street infrastructures along the site to bring public peace and to create feelings of safety and social bond for street users through developing road network, hierarchy, street furniture's amenities and

Developing street side green, recreation areas and open spaces and as well as raise public awareness and promote realization of the importance of green areas and biodiversity in the city.

5.1.2 Concept Plan

Issues identified in the SWOT analysis indicate the need to formulate the guidelines for the project strategy.

- **Street Design Principles**
  - **Permeability**-Design of vehicular and pedestrian routes to be visually appealing connections between different parts of streets and the number of alternative ways through an enhancing development to exploit opportunities to improve choice and convenience of movement.
  - **Accessibility -** Accessibility is the ease access a full range of facilities such as shops, leisure, and all areas of the public realm. Existing public space and new development should be accessible to the widest range of people both in terms of its location and physical design of spaces and buildings.
  - **Legibility-**Provide clear and identifiable circulation systems into and through street's large commercial blocks to improve pedestrian activity. The Image of The City and Its elements like paths, edges, districts, and nodes, should be clear for viewers.
  - **Variety/mixed-use -**Creating variety can help to attract people to live, work and play in the same area and helps to determine how well a place is used, and what economic and social activities it will support. It also incorporates dramatic and imaginative landscape and art features when reconstructing streets and/or sidewalks at key gateways.
  - **Durability-** It is important in achieving sustainable and adequate built environment. The use of high quality materials for surfaces should be a priority. The resistance of materials to wear is important if they don't require excessive maintenance till the end. In commercial areas providing necessary amenities for pedestrians like Benches, bike racks, planters, bollards, tree grates, and water fountains create a comfortable outdoor environment.

- **Sustainability -** Sustainability is referring to a range of things like, mixed uses, flexible buildings and spaces, sustainable construction, pedestrian convenience etc. It is also about maintaining and enhancing the quality of human life in the carrying capacity of supporting ecosystem and the resource base. Developments should be designed and constructed to take in to account the needs of future generation rather than just short term consideration.
- **Safety and Security -**A well designed built environment can help to engender feelings of safety and security. Unsafe environment and literally imprison people in their own homes, especially during the hours of dark, mixed uses, including residential accommodation and evening activities can increases the level of activity and surveillance in a place and thus the sense of security or safety.

.

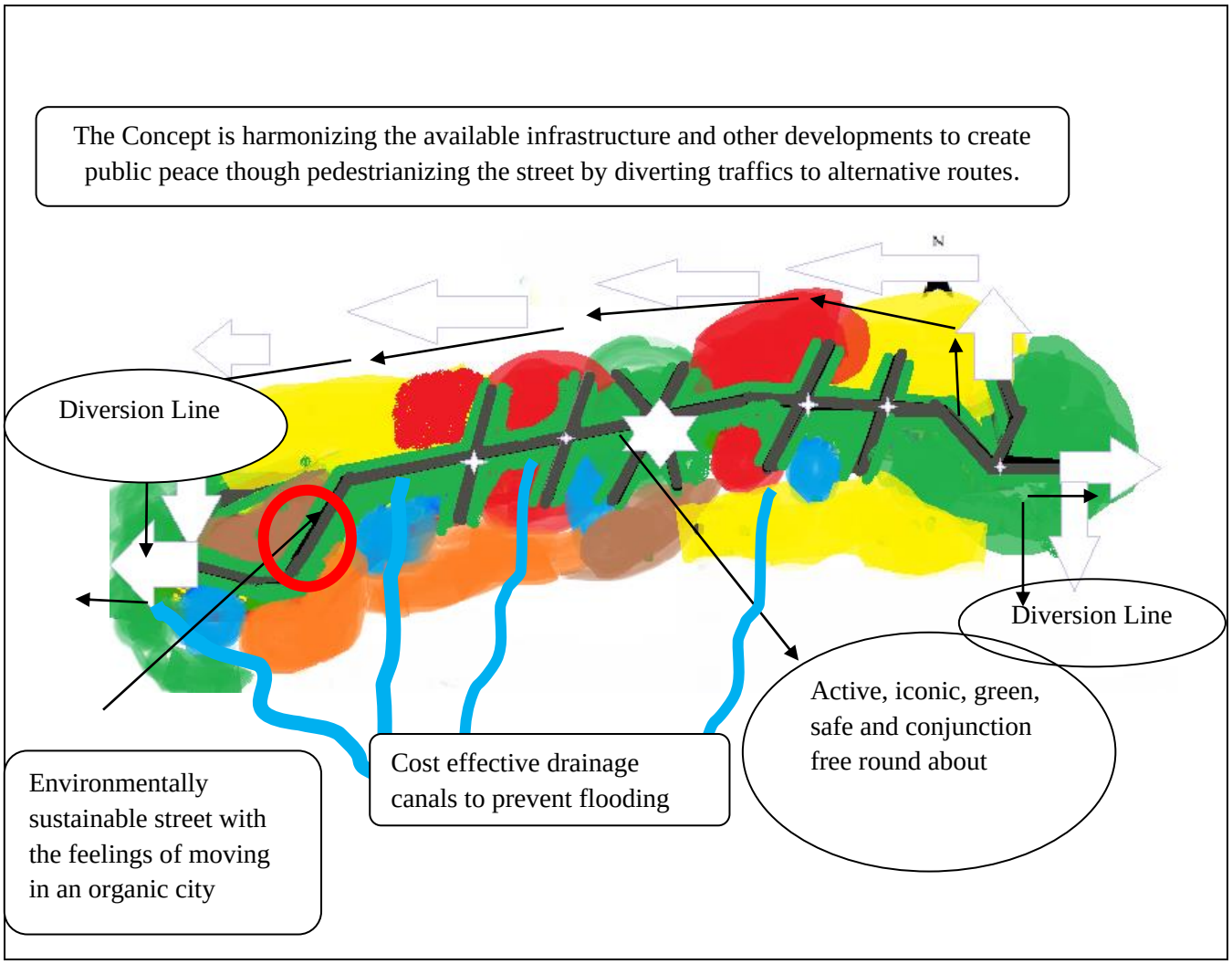


Figure 32: Concept diagram that shows ways of pedestrianizing street

(Source: Author)

5.2 Design Solutions for the Streets

A modification and upgrading of streets was implemented to facilitate development while reinforcing the pedestrian and vehicle network and formalizing roots to connect public spaces, residential areas and retail/commercial activities. Thus, the interconnected network of streets extends through all parts of the project site and connects them to adjacent services and facilities.

Table 15: Street width standard

No	Streets	Right-off-way width (m)			Remarks
		Core areas	**Intermediate Zone**	**Expansion Areas**	
1	Principal arterial -PAS	25,30	25, 30	30, 40, 50, 60, 100, 120 m	In existing built up areas, where widening is difficult, 25m streets are also categorized as principal arterial ones.
2	Sub-arterial-SAS	20,25	20,25,30	20 and 25 m	In some cases, existing streets of 30 m width with less important connections are categorized as sub-arterial streets.
3	Collector streets -CS	>11 and <20	>11 and <20	>11 and <20	Within the built-up area where widening is difficult, streets with width less than 12 m having important function in collecting traffic are also categorized as collector ones.
4	**Local Streets- LS**	4-10	8-10	10-12	Special design and traffic management considerations should be taken into account to use existing streets in the built-up city areas. Widening of streets targeting at optimum size should be considered in Redevelopment projects.

(Source: MUDCO for the Revision of Addis Ababa Master Plan, May, 2002)

Table 16: Streets Spacing Standards

No	Streets	Standard Spacing
1	Principal Arterial Streets **(PAS)**	Maximum of 1.5 Km
2	Sub-Arterial street **(SAS)**	0.8 km-1.5 Km
3	Collector Street **(CS)**	0.3-0.8 Km
4	Local Street **(LS)**	0.15-0.3 Km

(Source: MUDCO for the Revision of Addis Ababa Master Plan, May, 2002)

5.2.1 Design of Streets by Hierarchy

Concerning the street design of the study area an alternative mechanisms adopted is widening the existing streets that are not to the standards and redesigning the existing streets based on the requirements. To do so, some of the factors taken in to consideration include traffic considerations, land use features, physical and topographic features and Social and environmental factors. Hierarchically, the redesigned street network contains Principal Arterial Streets, Sub Arterial Street and the Collector Street.

The priority of order (phasing) is proposed based on the criteria used for proposal of the lines i.e. future land use, existing transport network, constraints and environmental impacts. Accordingly, the streets from Kidane-Mihiret Church church to Adama Town Ring road (Finfinne To Harar) with a total length of 7.2 km is redesigned to 30 m width in order to improve the network of paved streets and also to develop accessibility of the existing parts. The 30m width can accommodate 7 m carriage way (two lanes), 3 m pedestrian walk way in both direction and 2 m median, 3 m cycle lane**.** In this research 9 (nine) streets that creates junctions with the study site are redesigned with appropriate width and hierarchy and details to accommodate different street users. Table below shows the width and hierarchy of junctions redesigned.

Table 17: Redesigned Streets by hierarchy

No.	Street Locations/ Identifications	Current Names	ROW (m)	Hierarchy
1	Ring Road (Boulevard)	Dr. Ali Birra Avenue (starting point of Adama Town Ring Road)	40	PAS
2	Finfinne outlet to Harar outlet	Abba Gada Avenue (Kidane-Mihiret church)	30	PAS
3	Awash Hotel to Wanji Outlet	Wami Birratu Street	25	SAS
4	Darartu Square to Asella Outlet	Mammo Mazamir Link (Street)	30	PAS

5	Pan Afric to Sillasie Church junction	Bokkan Jima Street	25	SAS
6	Hani Hotel to Mugar cement factory	Siqqe Street	30	PAS
7	Alem Hotel to ASTU main gate	Shushi Buto	30	PAS
8	Darartu Square to Adama Town Police Station (district 4)	Aurora Street	25	SAS
9	St. Marry Church to Adama General Hospital	Bole Street	25	SAS

(Source: Author)

NB.*SAS =Sub Arterial Street *PAS = Principal Arterial Street

Table 18: Details of Cross section for 40 m, 30 m and 25 m right of row

Road width	**Pedestrian way width**	**Cycle lane width**	**Carriage way width**	**Median**
40 m – PAS	3 m at each side	3 m at each side	12.5 m at each side (three Lane)	1.5 m at the center
30 m – PAS	3 m at each side	3 m at each side	7.5 m at each side(two lane)	2 m at the center
25 m – SAS	3 m at each side	-	8.5 m at each side(two lane)	1 m at the center
30 m – PAS	3 m at each side	3 m at each side	7 m at each side(two lane)	2 m at the center

(Source: Author)

5.2.2 Redesigned Street Junctions

Map that shows redesigned streets and Junctions

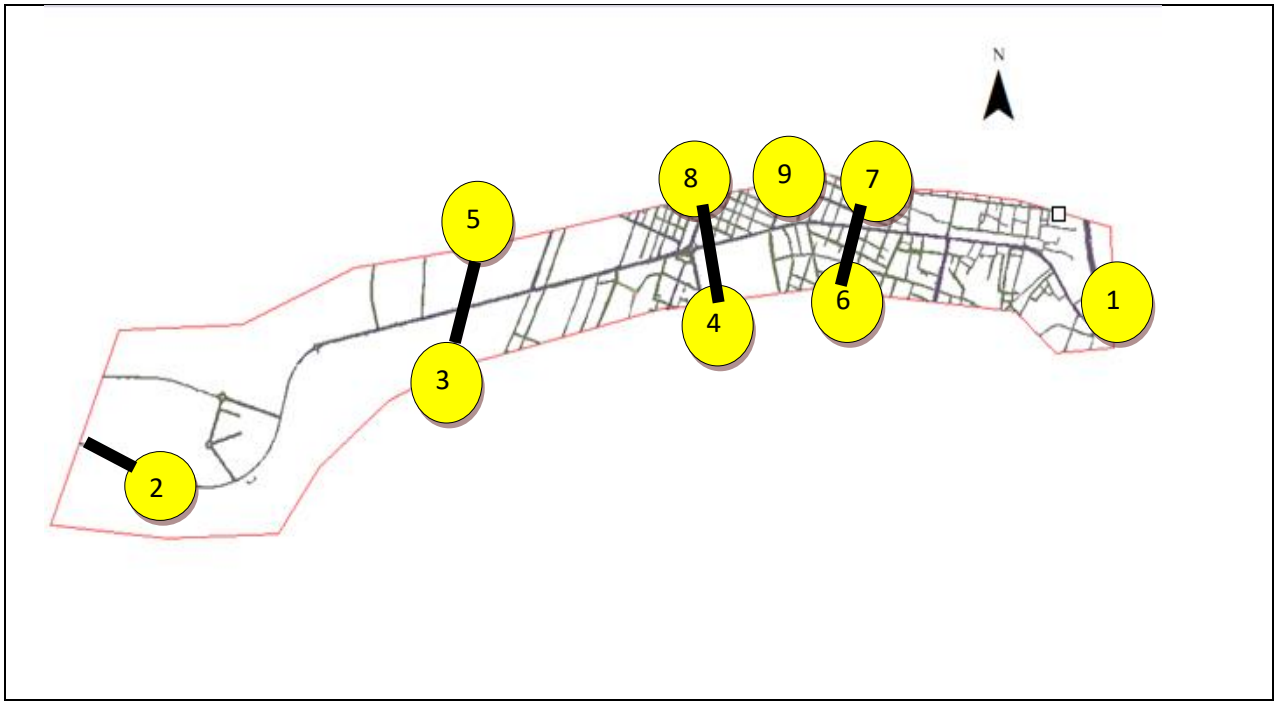


Figure 33: Redesigned streets and Junctions

Source: author from April- June 2019

NB: The numbers are coded according to table 15

5.2.3 Intervention Measures to Be Taken

1. Adama Town ring road (start point of Adama Town Ring Road)

A start point of Adama Town ring road or Dr. Ali Birra Avenue is redesigned with 40 m width (PAS) to accommodate diverted traffic from the study site. The detail proposal is shown in the figure below.

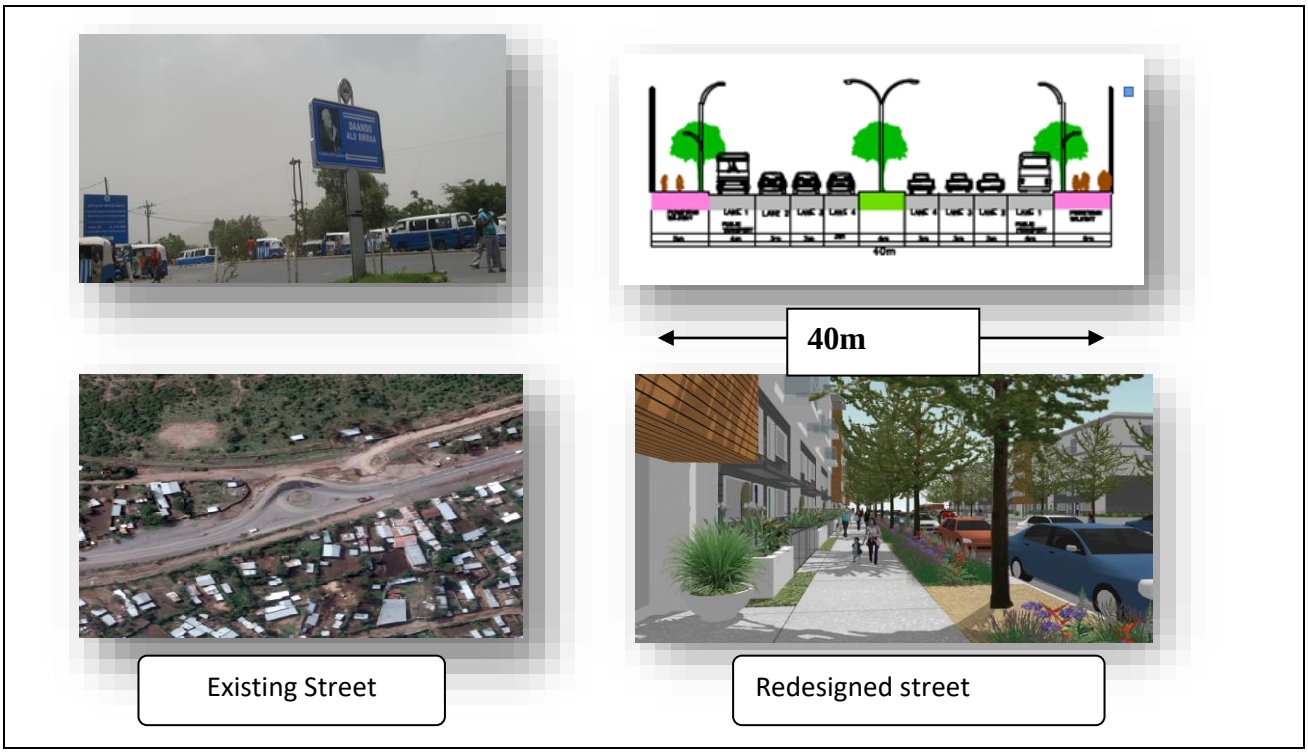


Figure 34: upgraded Street of Adama Ring road

(Source: author)

2. Main study area from Adama Town Ring Road to Kidane-Mihiret Church Church (Finfinne outlet to Harar outlet) street is proposed to 30 m wide PAS to insure the concept of street as a social place and to provide the road users to access the street with different transport modes like walking, cycling and other non-motorized vehicles.

   The main focus of the study is to promote walking and cycling as a primary modal choice to create healthy society. During redesigning works challenges referred in SWOT analysis are tried to be resolved. The Sections of street shows storm water drainage systems, standard walk way dedicated only for pedestrians with appropriate pavement material, bicycle lane, standard median and side greeneries to provide shelter for street users specially for pedestrians.

   The streets are designed for low speeds, pedestrians, cyclists and vehicles which can mix safely and in harmonized manner. Therefore conventional streets provide the most convenient, direct routes to places which cyclists and pedestrians, like everyone else, want to get to. Especially, more emphasis is given to pedestrian and cyclists.

A safe, attractive and well designed street encourages peoples to walk. The key considerations are:

- People prefer to walk along streets where they can be seen by drivers, residents and other pedestrians;
- If segregated footpaths are provided, they need to be well-connected and overlooked by houses and other buildings;
- All measures that slow traffic help pedestrians feel safer. At junctions, the use of raised surfaces and tight radii make it easier for pedestrians to cross;
- Well-designed shared surfaces avoid conflicts of movement yet encourage other activities to take place. To achieve this, subtle variations of material or bold changes of detail are appropriate, depending upon the location;
- Footpaths should lead where people want to go, rather than follow a preconceived geometry;
- Footpaths in new developments should be positive, direct and barrier-free.

Pedestrian Environment

Approaches utilized to design the pedestrian environment through the use of the'Five C' principles:

- **Connections:** Do good pedestrian routes connect the places where people want to go?
- **Convenience:** Are routes direct, and are crossings easy to use? Do pedestrians have to wait more than 10 seconds to cross streets?
- **Convivial:** Are routes attractive, well lit and safe, and is there variety along the street?
- **Comfortable:** What is the quality and width of the footway, and what obstructions are there?
- **Conspicuousness:** How easy is it to find and follow a route? Are there surface treatments and signs to guide pedestrians?

The figure below shows redesigned street network

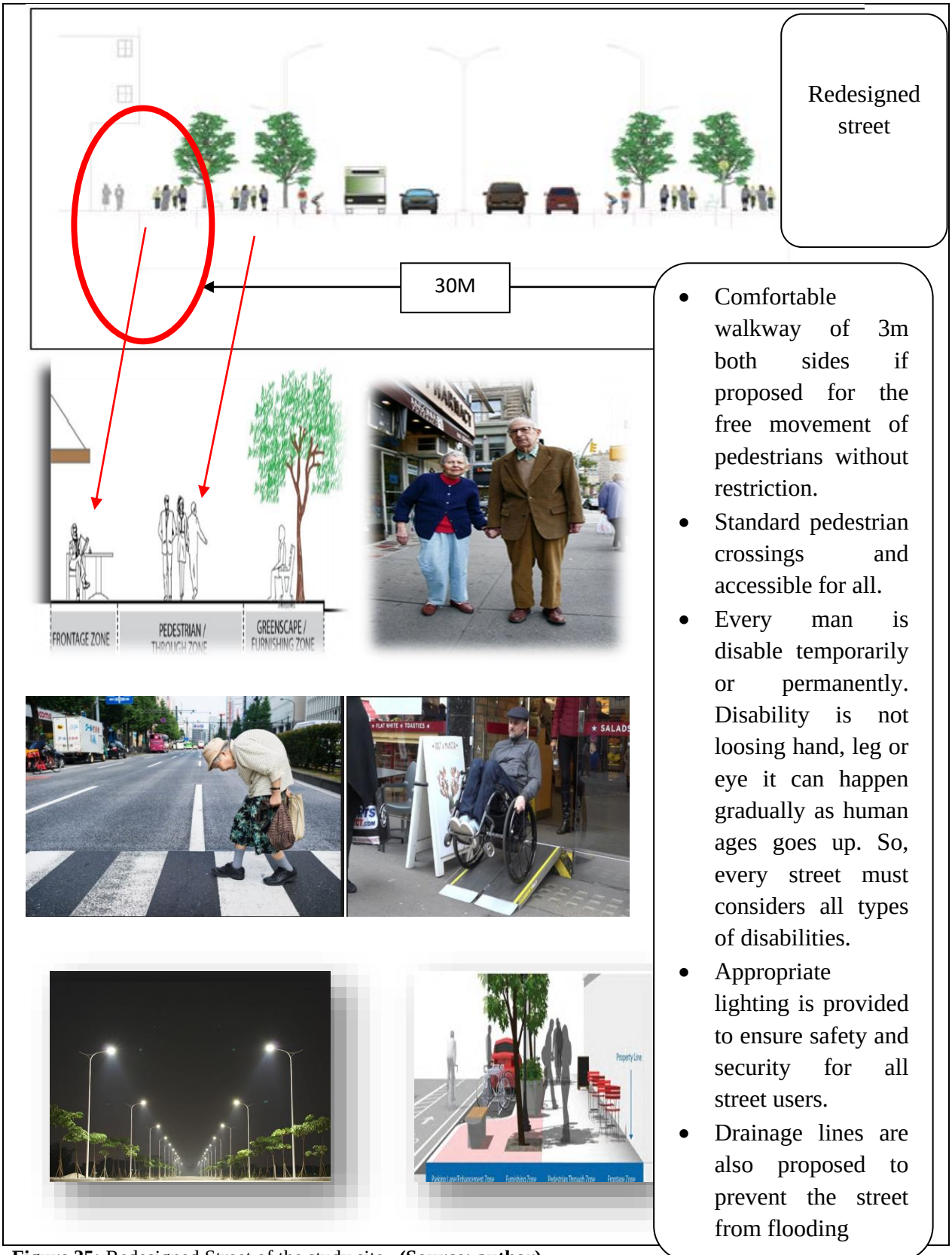


Figure 35: Redesigned Street of the study site **(Source: author)**

3. The third street from Hani Hotel to Mugger Cement Factory and from Alem Hotel to ASTU main gate is also upgraded to 30m width considering the traffic flow of an area.

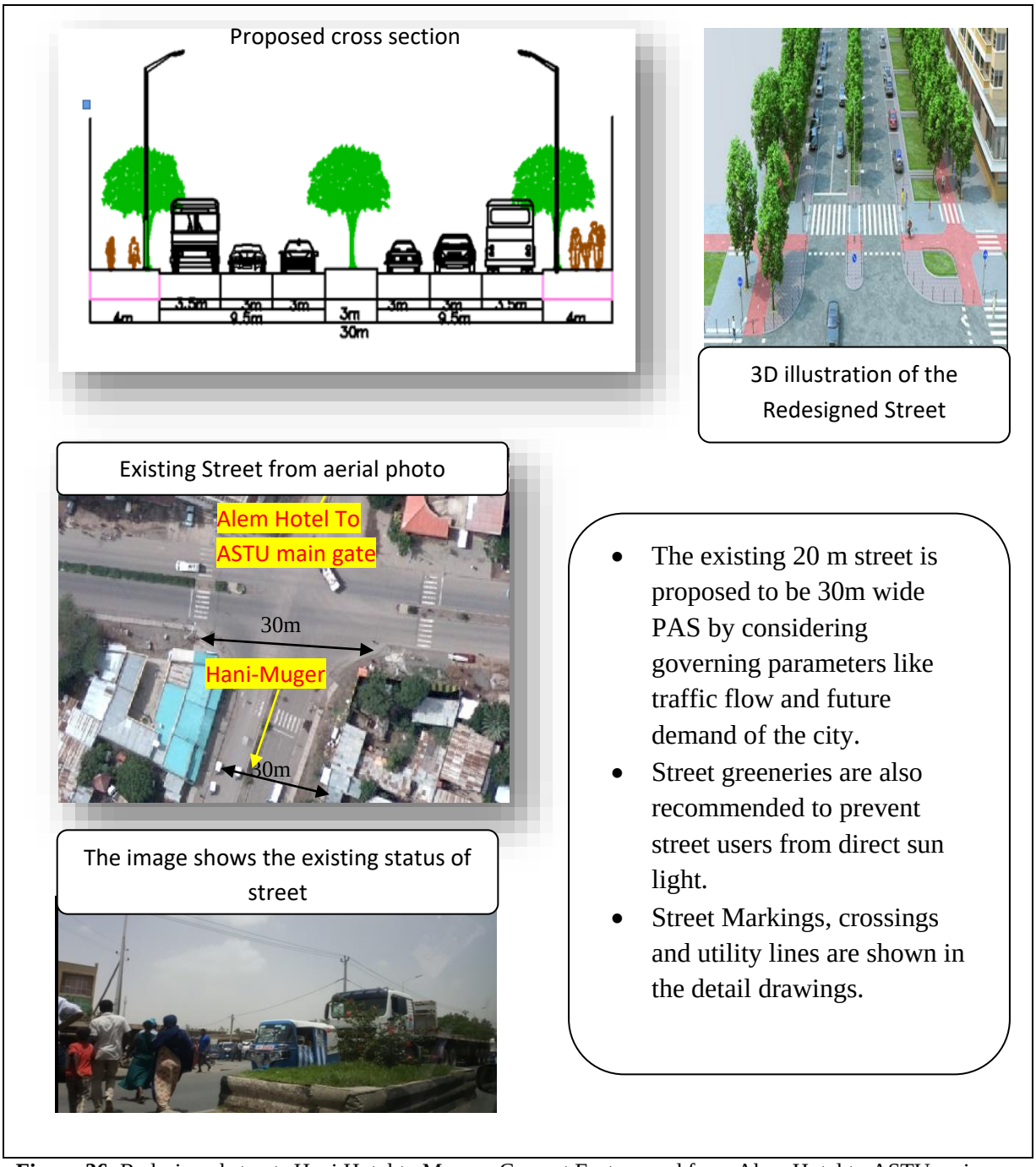


Figure 36: Redesigned streets Hani Hotel to Mugger Cement Factory and from Alem Hotel to ASTU main gate

(Source: author)

4. Three streets that junctions to the study site namely Awash Hotel to Wanji Outlet ,Pan Afric to Sillasie Church junction ,and Darartu Square to Adama TownPolice Station

(district are redesigned to 25m width SAS. The details of proposal are presented in the figure below.

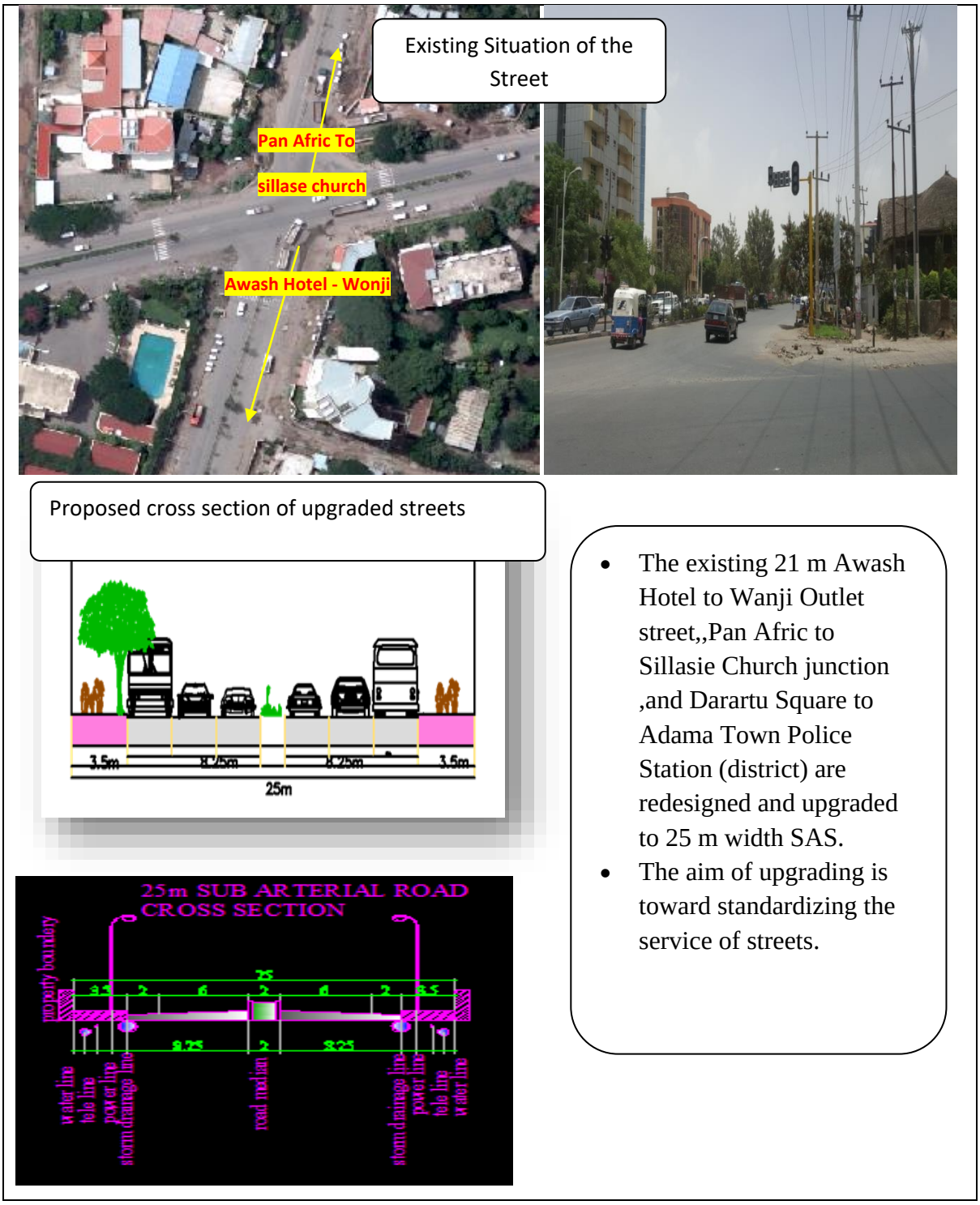


Figure 37: Upgraded Design of Awash Hotel to Wanji Outlet, Pan Afric to Sillasie Church junction, and Darartu Square

(Source: author)

5.3 Roundabout

The roundabout around Darartu square which is below the standard is brought to the standard and redesigned. Due to enormous increase in the traffic in the recent times, most of the existing roundabouts have become congested and is viewed as a cause for delays. In order to overcome this delays, roundabouts should be improved geometrically and also by increasing the number of approach and circulating lanes. These changes should be carried out only after detailed studies. To do so, some of the factors taken in to consideration includes Traffic considerations, Land use features, Physical and topographic features, Social and environmental features factors.

I. Design Considerations

- Slow entry speeds
- Appropriate number of lanes
- Smooth channelization
- Adequate accommodation for design vehicles
- Meeting needs of pedestrians and bicyclists
- Appropriate sight distance and visibility

For the re-design of the roundabout the researcher primarily considers the design speed, the geometric elements, path alignment which will balance the entry speed and path alignment with that of entry and exit lanes designed without too much separation to avoid problems. The size of a roundabout, measured by its inscribed circle diameter, is determined by a number of design objectives, including design speed, path alignment, and design vehicles as discussed above. Selection of an initial inscribed circle diameter is the first step towards preparing a design. The selected diameter may be somewhat subjective, but its ultimate size is an output of meeting other objectives (e.g., speed control, design vehicle, etc.). Smaller inscribed circle diameters can be used for some local street or collector street intersections where the design vehicle may be a fire truck or single-unit truck. Larger inscribed circle diameters generally provide increased flexibility for the entry design to meet design criteria (e.g., speed, adequate visibility to the left, etc.) while accommodating large design vehicles. The table below provides design elements and dimensions used for the redesign of the case site.

Table 19: Design elements and dimensions for Derartu roundabout

Design elements	Dimensions
Design speed	40km/h-50km/h
Inscribed circle diameter	45m
Circulatory carriageway width	20m
Central island diameter	20m
Cross slope	2%
Splitter island	3m
Pedestrian lane design	3m
Bicycle lane design	3m

(Source: author)

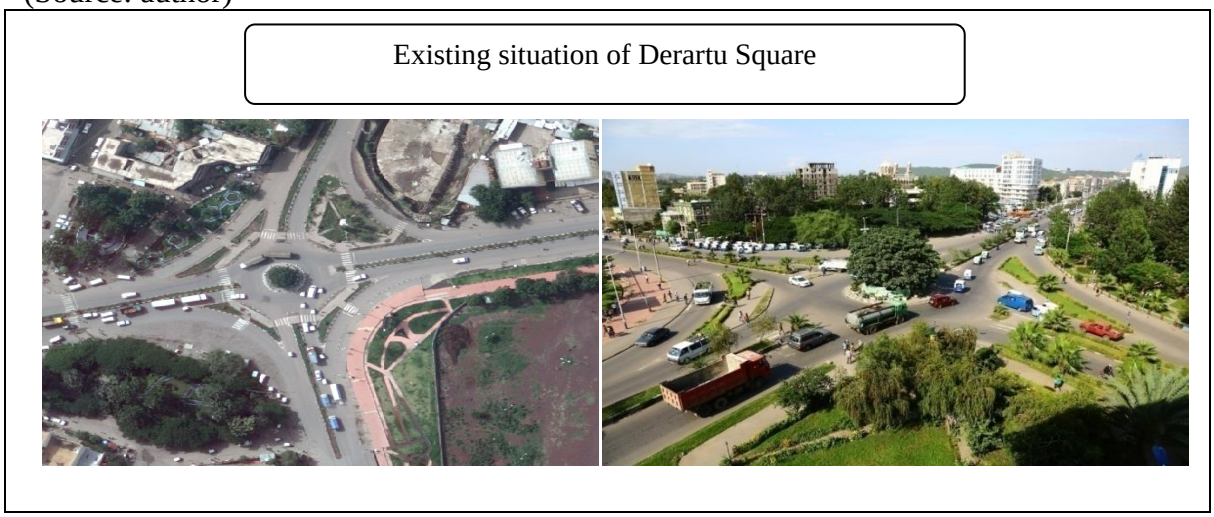


Figure 38: Existing situation of Derartu Square

(Source: author)

5.3.1 Redesigned Roundabout

In the study major problems of Derartu square is identified to set possible solutions towards functionalizing and increasing the service of the roundabout.

- The first step in redesigning the roundabout is widening and standardizing of adjacent streets.
- Addition of Visible curbstone for the purpose of edging.
- Planting bush trees and pedestrian sized sculptures that indicates the culture of the city.

- Signalizing the round about using traffic light for the smooth flow of traffic.

Redesigned Roundabout at Derartu Square

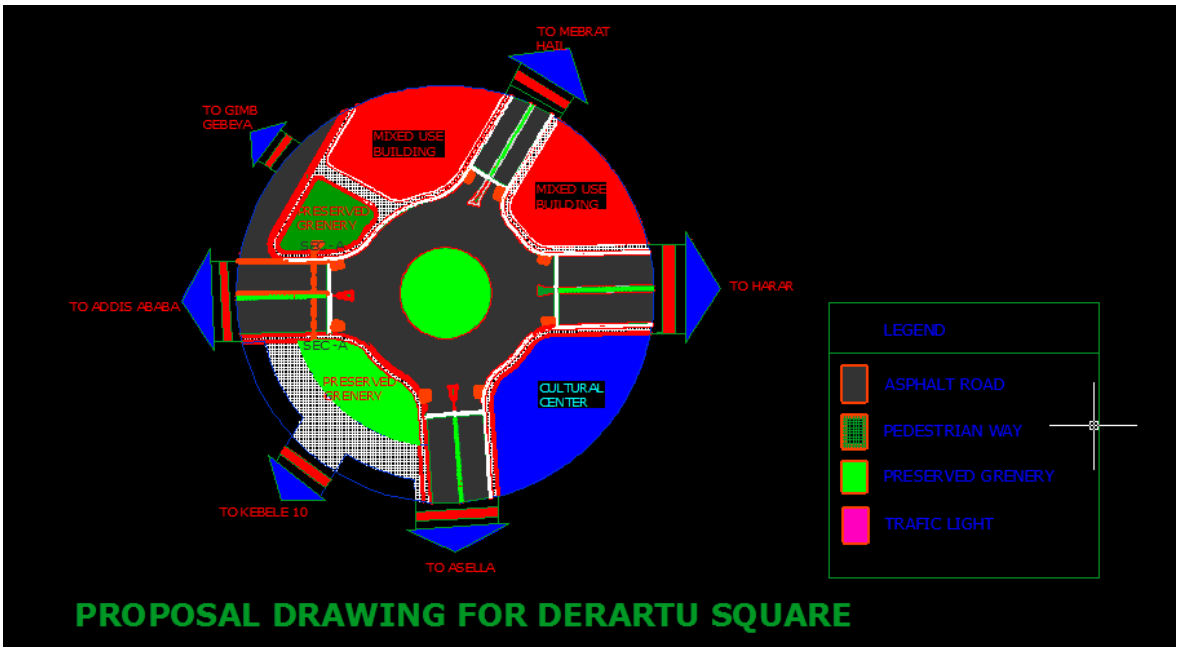


Figure 39: Proposed Roundabout

Source: (author)

5.4 Drainage Line

The existing flood problem of the city requires development and implementation of short and long term flood mitigation strategies. Obviously, the long term plan needs detail scientific analysis using appropriate spatial and hydrological data which further requires more time and budget. However, short term flood mitigation plan has great role in mitigation of seasonal flood and reduces the disaster in specific season in the area where there is only seasonal rainfall like Adama town.

Hence, in this research, special considerations were given to social, economical, ecological factors and available resources and time for implementation, the most appropriate solutions were proposed. The cross section of drainages varies in size to accommodate the discharge flows from upper catchment of the city. Since solid waste management of the city is poor,

open ditches with precast concrete cover is proposed to make it easy for cleaning and maintenance. The map below shows possible drainage lines proposed.

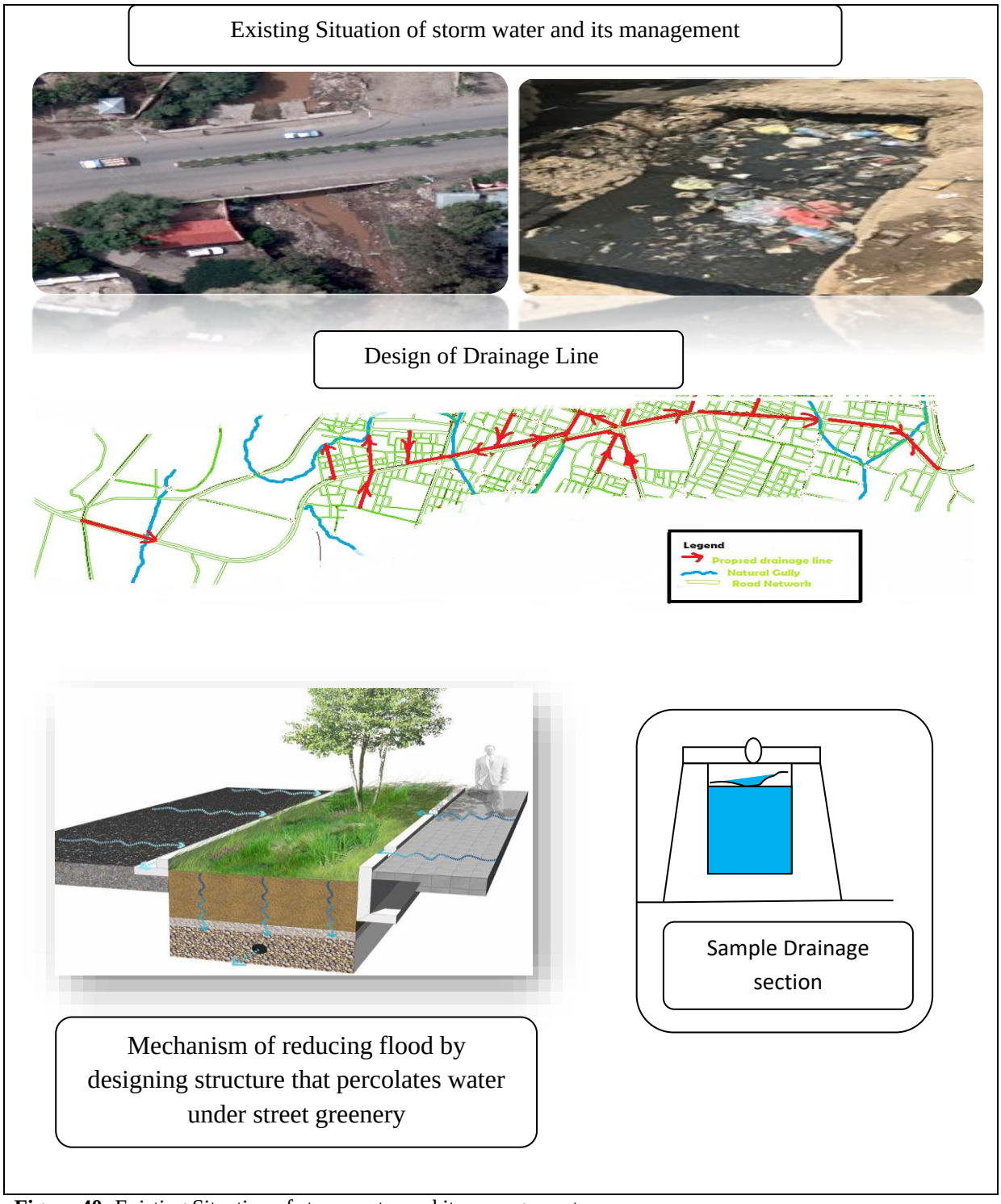


Figure 40: Existing Situation of storm water and its management

(Source: author)

5.5 Parking

Cars are stationary for most of the time. Where and how they are parked can be a major factor in the quality of a development. Having decided what level of parking provision to make, the main consideration is how to incorporate parking in a development without allowing it to dominate everything around.

Considering well-designed off street car parking, shaded by trees and screened by hedges, shrub beds or grassed mounds are a relief from stark expanses of paving and the integration of the landscape development with the design and construction of the car park is an essential requirement for both aesthetic and functional reasons. A minimum of 15 percent of the car park area is to be landscaped with trees or shrubs. This also helps to create sustainable environment.

Two Parking sites are proposed for long vehicles in order to avoid on street parking of long vehicles which deteriorates streets lowers their life time and serviceability. The parking lot is proposed to be paved with permeable paving materials.

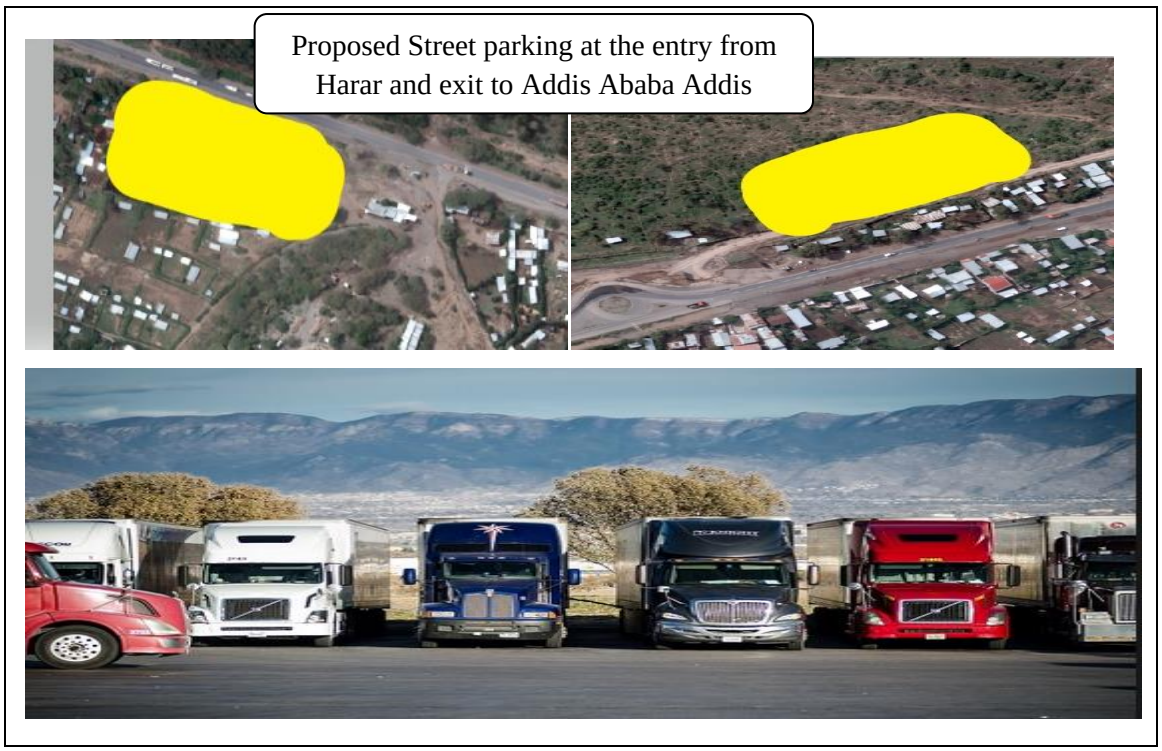


Figure 41: Proposed Street parking

Source: [https://www.gettyimages.com /photos/parking lots]

5.5.1 Plants Types Proposed For Parking

Scientific name: **Ficus Sur**

- Common name :**Sholla**
- Type: tree/shrub
- Height: 6m
- Foliage: evergreen
- Feature: Resistance to storm damage
- Soil: Will grow on poorly drained soil
- Climate: Will grow in hot, dry areas and moist areas
- Use: shade / ornamental, screening and parking shades.
- Native: indigenous
- Scientific name : **Delonixregia**

- Common name : **Flame tree**
- Habitat: Tree
- Leaf: Feathery fern like leaves, deciduous, it drop all its leaves once a year.
- Flower: Red flowers, pods are dark brown when they mature.
- Bark: gray with smooth texture, rough when mature.
- Form: single trunk, spread branches.
- Height: height greater than 15 m.
- Width: spread more than it is tall.
- Climate: Grow in tropical and sub-tropical regions.
- Use: Ornamental, in gardens, public parks and Suitable for streets and car parking areas.
- Native: exotic

Figure 42: Plant types Proposed for parking (Source: author)

5.6 Green Infrastructure

Green streets are a vital component of the town in a green structure. They improve watershed health and conserve the existing and future conveyance capacity of the sewer system. Green streets transform impervious street surfaces into landscaped green spaces

that capture storm water runoff and let water soak into the ground as plants and soil filter pollutants.

Green streets convert storm water from a waste directed into a pipe, to a resource that replenishes groundwater supplies. They also create attractive streetscapes and urban green spaces, provide natural habitat, and help connect neighborhoods, green space, parks, and recreational area.

Green streets assist the city to observe with storm water regulations by reducing the amount of untreated water flowing to the city's storm drains.
Treatment occurs through bio-degradation of pollutants through soils, plants, and sun light. Use of the adopted Green Street Standard Plans will also reduce urban "heat island effect" by Increasing green space and permeable areas. Streets are an integration of the gray components, green components, blue components, seats, signs, pavements, Sculptures, monuments and fountains, Fences and walls, Steps and ramps and Lights.

5.7 Points Considered During Proposals

5.7.1 The Gray Components

Pavements

- Providing permeable Pavements within green open spaces, in order to improve storm water management and groundwater recharge but, only access roads and entrances may have impermeable surfaces.
- Pavements should be of long term service with the required comfort and convenience.

5.7.2 Lights

- All lights shall minimize upward light spill and light pollution and shall use energy efficient luminaries.
- Light fixtures shall be durable, resistant to weather extremes, vandals and easily maintained.
- Lights should be installed in harmony with the design and function of the respective green infrastructure element and its adjusted buildings.

- ❖ Illumination levels should not exceed the minimum level required to provide safe conditions based on the local conditions.

5.7.3 Seats

- ❖ Seats should always be provided in both sunny and shady areas of the green open space.
- ❖ Seats should not be located in grass since the maintenance of the grass around and beneath the seats is difficult. Permeable pavement under the seats should be preferred.
- ❖ Seats should be well designed to withstand moisture after rain.
- ❖ Seats should be easy to clean and maintain, resist vandalism and discourage damage.
- ❖ Seats should be 42 cm above the ground and at least 40 cm deep.

The following clearances should be maintained when installing seats:

- 7.5 cm minimum on either side of the seat;
- 12.5 cm minimum from fire hydrants;
- 2.5 cm minimum from any other amenity, utility, or fixture;
- 12.5 cm minimum, ideally 15 cm clear path to provide an additional 2.5 cm for people's legs, in front of the seat when located at the back of a sidewalk, facing the curb;
- 2.5 cm minimum clear path must be provided behind a seat when located at the front of a sidewalk, facing the curb.

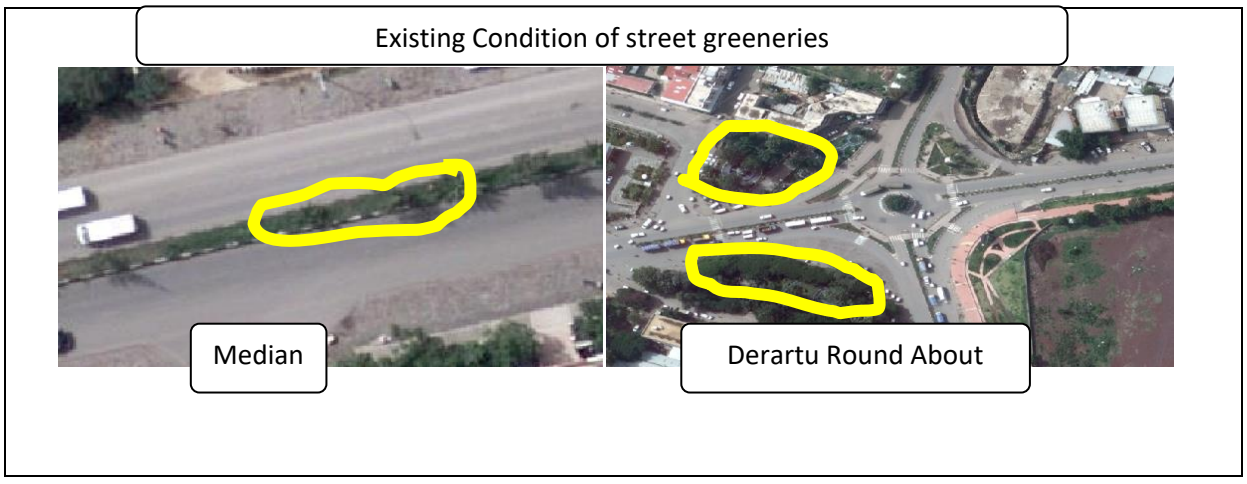
5.7.4 Signs

- ❖ Signs shall provide information where it is required.
- ❖ Signs shall be placed in a way that it doesn't create obstacle (for pedestrians).

Table 20: Standard of greenery to be planted on median

SN	Street Type	Average sidewalk width (in m)	Median width (m)
1	Urban Motorway	--	2.0m/2.5m
2	Principal arterial (PAS-50m)	Approx.5.0m (on both sides)	1.5m/2.0m
3	Principal arterial (PAS-40m)	Approx.5.0m (on both sides)	Approx. 1.0m
4	Principal arterial (PAS-30m)	Approx.4.5m (on both sides)	Approx. 1m
5	Sub arterial (SAS-25m	Approx.3.5m (on both sides	Approx. 1m
6	Collector (CS-20)	Approx.3.5m (on both	
7	Collector (CS-15)	Not less than 2m(preferably both sides)	
8	Local 10m	To be decided on local conditions (not less than 1.3m)	
9	Local 6m	To be decided on local conditions (not less than 1.3m)	

- Source: Planning Norms and Standards for Road, Transport and Utility Networks



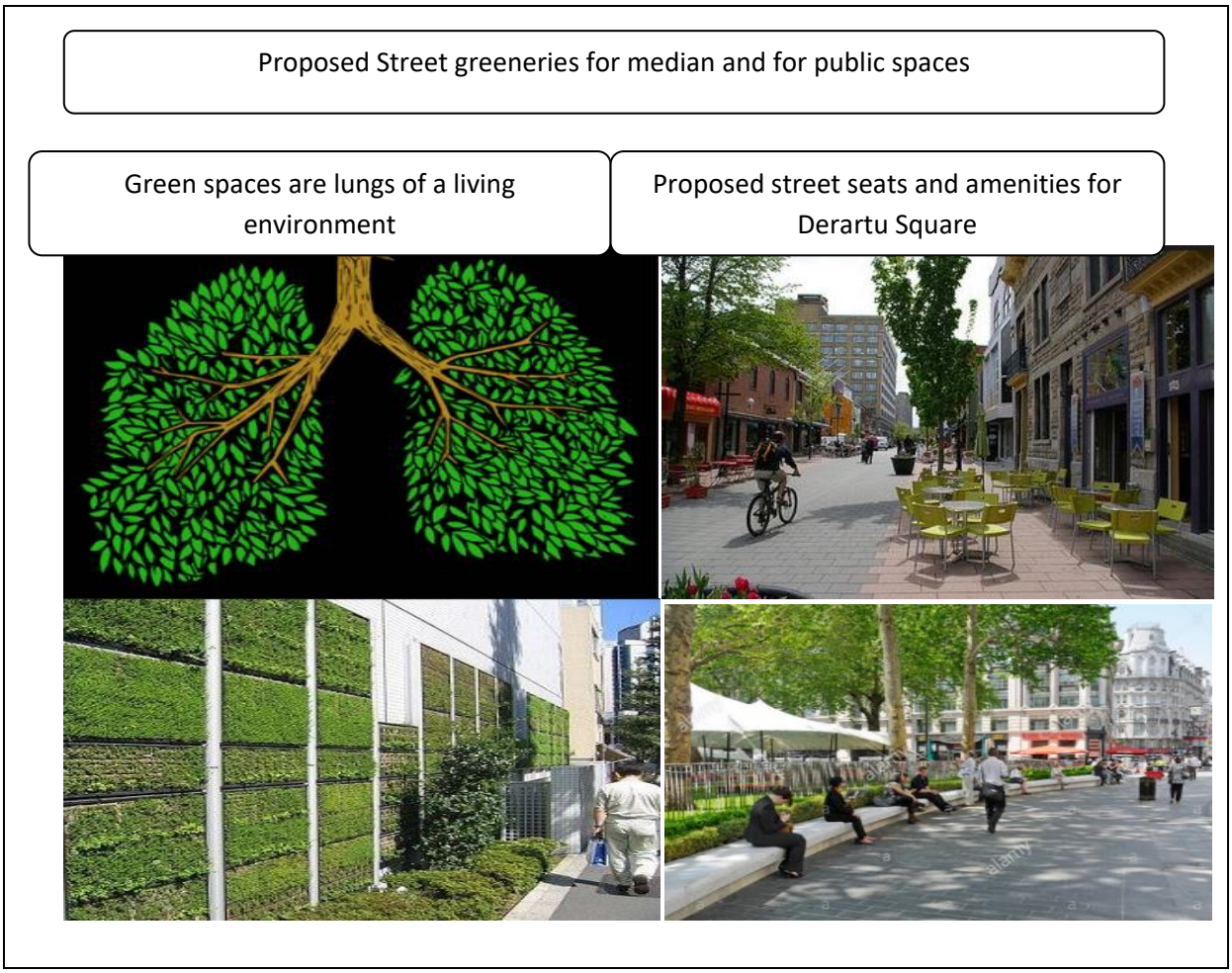


Figure 43: Proposed Street greeneries for public spaces

(Source: author)

Proposed median greeneries and street side greeneries

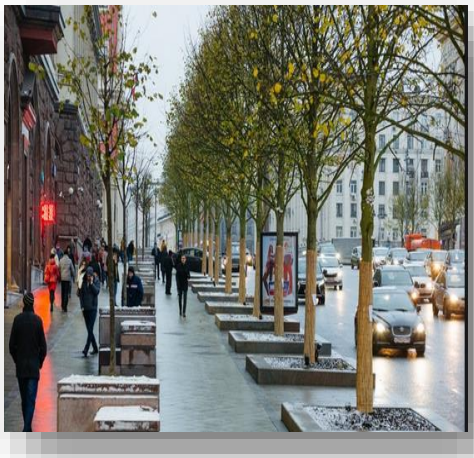


Figure 44: Proposed Street greeneries Median

(Source: author)

Proposed street amenities like street light and dust bins

Dust Bins

Pedestrian Scaled Lightings

Figure 45: Proposed street amenities like street light and dust bins

(Source: author)

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The major conclusions drawn from the analysis and triangulation of the information gathered in different forms are generalized as follows.

The success of street infrastructure depends upon the co-ordination between the three primary elements namely: the vehicles, the street ways, and the street users. Their characteristics, affects the performance of the infrastructures therefore, there should fairly good understand about them. The need of street is to provide the needs of pedestrians, bicyclists, transit users, motorized-vehicle users, and users of rail and aviation facilities in a manner that is sensitive to the cultural and environmental amenities.

Well-designed streets enhance mobility, support growth management and land development objectives, promote walking, bicycling, and use of public transit, maintain high quality new and established neighborhoods, facilitate the preservation of natural resources and make efficient use of public infrastructure.

The study site is encroached with various substandard elements that have no substance in standard street design. As a major corridor the street lacks pedestrian way, standard sidewalk and median greenery, and lack of variety of activities enjoyed by pedestrian's robustness, inaccessible for all and no bus stops. The other problem is lack of light and illumination during night, absence of networked drainage, impermeable and well furnished open spaces at scale of pedestrians and lacks corridor planning.

The assessment conducted implies as street lacks change accommodative character and lacks well planned urban design details to accommodate street parameters. Therefore the researcher suggest, setting an intervention mechanism to treat the street components to their standards is must.

- The major finding of this paper is the gap between plan formulating and approaches to realize street infrastructure planning, un-integration of various stake holders who work on infrastructure planning and expansion results chaotic environment which is not comfortable for residents and incurs unexpected cost on municipalities.

6.2 Recommendation

The city's infrastructure provision challenges and opportunities analysis has resulted in major conclusions as indicated above. The following recommendations are given based on the conclusions:

- Designing of main streets to be distinctive from other streets and, reinforcing the image of a "city in a park." both within the right of- way (ROW) and on adjacent private development, by utilizing features such as gateways, street trees, median plantings, special lighting, separated and wider sidewalks, crosswalks, seating, special signs, street names, landscaping, decorative paving patterns, and public art is recommended o create a socially interactive city.
- Design treatments and design features could include wider sidewalks, special signs, colorful planting, seating, improved lighting, prominent crosswalks, decorative paving patterns and public art. These features may be achieved through a combination of public improvements in the right-of-way and private improvements consistent with city design guidelines.
- A combination of aligned building facades, passageways, covered walkways; consolidated parking areas, signs, markings, special paving, and other methods can be used.
- Encourage special streetscape design for designated intersections that create entry points into the city or neighborhoods or that warrant enhanced pedestrian features. Art may be incorporated into streetscape features such as sound walls.
- There must be an attitudinal change between both from designer, government and community that if a city's street looks interesting, exclusive. Self-regulating, applying all street furniture consider road design element increase the accessibility of users and includes appropriate space.

- Coordination of the activities of the infrastructure through joint planning would enhance efficient utilization of resources. This has to be done by the City Administration to the level that best integrate the planning and performance of the infrastructure projects and further strengthening the private- public partnership in the process.
- Prospects of the infrastructure provision have to be worked out strategically by respective authorities given the existing supply gap and highly growing urban infrastructure demand in the town.
- Transparency and accountability would still be important component in overall infrastructure provision to the city. This aspect of the provision of infrastructure has to improve by respective offices.
- There should be scheduled monitoring and evaluation programs toward streets design and their implementation.

REFERENCES

- Samson Kassahun and Alok Tiwari (2014) Urban Development in Ethiopia: Challenges and Policy Responses.
- Better Growth, Better Climate in Ethiopia Supporting Ethiopia's development ambitions through green growth December 2015 –April 2016A joint project by NCE's Ethiopia Partnership (EDRI, GGGI and NCE).
- Tsegaye Tegenu(2010) Urbanization in Ethiopia: Study on Growth, Patterns, Functions and Alternative Policy Strategy; Department of Human Geography, Stockholm University.
- Statistical report of 2007 by Ethiopian federal democratic republic of Ethiopia population census commission.
- Abebe Zelaul (n.d) Urbanization for National Development in Ethiopia, Economic Focus.
- Ministry of Finance and Economic Development (MoFED) (2006) Ethiopia: Building on Progress; A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/06-2009/10) Volume I: main text.
- Worku, Ibrahim (2011*)* Road Sector Development and Economic Growth in Ethiopia: EDRI Working Paper 4. Addis Ababa, Ethiopia: Ethiopian Development Research Institute.
- Tova María Solo, Eduardo Perez and Steven Joyce (1993) Constraints in Providing Water and Sanitation Services to the Urban Poor; USAID WASH Technical Report No. 85.
- Street Planning and Design Fundamental national association of New York City transport official's transport of by Jennet Sadik Khan.
- Adama Town profile by Ato Reshid Mohammed
- Infrastructure | Define Infrastructure at Dictionary.com
- Book of urban design and street and square Cliff Moughtin third edition Ciff Moughtin with Peter Shirley second edition.
- urban design compendium, third edition by Llewelyn Davies Yeang
- Planning Norms and Standards for Road, Transport and Utility Networks of Ethiopia).

- Wolf, K.L. 2006. Roadside Urban Trees: Balancing Safety and Community Values. Arborist News 15, 6:56-58.
- 1988 MUTCD) UNITED STATES Manual on Uniform Traffic Control Devices; Pavement Markings.
- David Schrank and Tim Lomax, 2003 Urban Mobility Report) available online at: http://mobility.tamu.edu/ums/. Transportation Research Record No. 1932, (2005): 54-60
- Aschauer, D.A. (1989c), "Public Investment and Productivity Growth in the Group of Seven", Economic Perspectives, 13(5), 17-25.
- Lynde, C. and Richmond, J. (1993a), "Public capital and total factor productivity", International Economic Review, Vol. 34, No. 2, pp. 401-414..
- Fernald, John, *G.* 1999. "Roads to Prosperity? Assessing the Link between Public Capital and Productivity." American Economic Review, 89 (3): 619-638.
- Wikipedia, the free encyclopedia

Appendix

Title: Street Infrastructure Planning

(The Case of Adama Town Ring Road to Kidane-Mihiret Church through Derartu Square)

Prepared By: Asia Esa

Date _____

Introduction

As part of my MSC research thesis at Adama Science and technology University, Department of urban planning and design ; I am conducting a survey that investigate the challenges and prospects of Street infrastructure planning through urban planning and design, The Case Of Adama Town ring road to Kidane-Mihiret Church through Derartu square. I will appreciate if you could complete the following questionnaire. Any information obtained with this study that can be identified with you will remain confidential.

PART I: Respondent Details

Sub city_____ **Kebele**_____

Name (*Optional*) _____ **Age**_____

1. Gender: Male ☐ Female ☐

2. Educational level

A. Diploma D. Second Degree

B. Degree F. above Secondary Education

C. Primary education G. Other (specify) ----------

PART II: To Infrastructure Sub-Sector

1. What is the current status of street infrastructure in the city?

---

2. What are the challenges of streets in your city in general?

A. Conjunction B. sub standard C. absence of utility line D. Absence of proper signage E. poor provisions of street infrastructure F. lack of setbacks G. all

3. Is the study area mostly affected by the above reason? **YES** **NO**

4. Do you think the area needs planning interventions? **YES** **NO**

5. What contributes the challenges?

A. No attention given by the municipality B. Lack of community participation

C. Corruption and nepotism from the authority D. If other, specify_____

6 Is there existing street infrastructure in the study area? **YES** **NO**

7. If you answer is **No** to question no 6 please specify

_____

_____

_____

8. Do the existing street infrastructure mach's with the general standards of Ethiopia?

YES NO

9. If your answer is **YES** to question no 8 please specify

_____

_____

_____

10. What is the impact of improper utilization of street infrastructures development on public, private and community in general?

_____

_____

_____

11. As your institution is there street infrastructures constructed on the study area within 5 years?

YES **NO**

12. If you answer ; **YES,** please dot down their lists

_____

_____

_____

13. If you answer: **NO** please reason it out

_____

_____

_____

14. If your answer to questions no 13 is **YES** what are the challenges faced during implementation

_____

_____

_____

15. What kind of coordination is exists between your institution and other infrastructure service givers like Tele Elpa and etc in planning jointly and implementing?

16. To what extent natural hazards like flood is controlled from affecting street and public properties during rainy season?

17. Do you think as there are appropriate traffic signals on the study area? **YES** **NO**

18. What is the effect of the two round about existed on the study area on general condition of street function and traffic flow?

_____

_____

_____

19. Is there planned and participatory street infrastructure provision mechanism in the town?

A. Somehow participatory B. Not participatory C. No clear mechanism

20. How satisfying is the quality of streets in the city

A. Very standard and satisfying B. More or less standard quality

C. Below standard quality D. Very low quality road

21. What do you think are the major challenges to ensure well planned street infrastructure to the community in the town? Rate according to the level of importance to you, (1 for the most important factor).

A. Lack of municipal financial capacity

B. Lack of community participation

C. Excessive bureaucratic procedure and corruption

D. Excess demand from the population

E. Topographic challenges

F. Limited Technical capacity

G. Unplanned spacial expansion of the town

H. System of governance and administration

I. Lack of public-private collaboration

J. If other, specify_____

22. How fast and regular is the response for maintenance of the existing street infrastructure in the town?

A. Excellent B.V. Good C. Good D. Fair E. Poor

---

23. How do you rate the coordination among the three sub sectors in provision of the services?

A. Excellent B. Good C. Fair D. Poor E. Very poor

24. Please suggest and recommended corrective measures to be taken to overcome problems related with titles.

_____

_____

_____

25. What will be appropriate procedures to be taken before implementation?

_____

_____

_____

Part II: For Land Management Sub Sector

1. What is the current status of street infrastructure in the city?

_____

_____

_____

2. What are the challenges of streets in your city in general?

A. Conjunction B. sub standard C. absence of utility line D. absence of proper signage E. poor provisions of street infrastructure F. lack of setbacks G. All

3. Is the study area is mostly affected by the above reasons? **YES** **NO**

4. Do you think the area needs planning interventions? **YES** **NO**

5. Is there a willingness of the city to maintain the master plan of the city around the study area?

_____

_____

_____

6. What types of land uses exist within 30m radius of the study area?

_____

_____

_____

7. How land use pattern of the area affects street infrastructure provisions of the area?

_____

_____

_____

_____

8. Is there plan violation around the study area? **YES** **NO**

9. If yes please specify

_____

_____

_____

10. What do hierarchy of streets looks like?

_____

_____

_____

_____

11. Is there appropriate set back in the study area? **YES** **NO**

12. If your answer for question number 11 is **NO** what action is taken to maintain the master plan of the area?

_____

_____

_____

13. Is there informal settlement or informal expansion of public or private utilities' on the main street?

13. If **YES** what corrective or preventive method is used?

_____

_____

_____

14. During plan preparation what kinds of natural hazards are considered and which one was given high attention than others and why?

_____

_____

_____

15. Is there proposed solutions planned for the future to guide street infrastructures as per the master plan of the city?

_____

_____

_____

_____

_____

14. is there monitoring and evaluation program on effective use of street for their intended purpose?

_____

_____

_____

_____

Part III: For Greenery Sub Sector

1. What is the extent of urban greenery in the study site?

   _____

   _____

   _____

   _____

2. What are the major challenges to practice sustainable urban greenery on street?

   _____

   _____

   _____

   _____

3. Is there standard greenery and public amenity around the study area?

   _____

   _____

   _____

4. What kinds of median greenery area recommended in urban streets?

   _____

   _____

   _____

5. What is the mechanism of watering median greeneries in the study area?

   _____

   _____

   _____

6. As an institution what do you recommend on the general street greenery of the study area?

   _____

   _____

   _____

   _____

   _____

Part IV: For Transport Office

1. What are the major challenges faced on the study area from transport point of view?

   _____

   _____

   _____

2. Do you think the area needs planning intervention? **YES** **NO**

   _____

   _____

   _____

3. How much vehicles pass through the street per day in an average?

   _____

   _____

   _____

4. Is there accidents encountered due to improper street infrastructure? **YES** **NO**

   _____

   _____

   _____

5. What is the benefit and problem of the two roundabouts existed on the study area?

   _____

   _____

   _____

6. What action should be taken to overcome challenges regarding roundabouts?

   _____

   _____

   _____

7. What will you suggest if it will be demolished and signalized?

   _____

   _____

   _____

   _____

8. Is there adequate number of lighting and illumination which ensures safety and security for users? **YES** **NO** **.**If You Say **NO** Please Specify

_____

_____

_____

9. Is there a traffic sign on the study area if you say yes s it the standard one? **YES** **NO**

   If you say **NO** please specify.

_____

_____

_____

   Is there dedicated bus or taxi terminal? **YES** **NO**

   If you say **NO** please specify.

10.

_____

_____

_____

11. What will you suggest generally from transport point of view about the study area?

_____

_____

_____