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A move from vehicular dominated roundabout to Human Centered Imageable Node for Addis Ababa

The case of Diaspora Roundabout

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Declaration

I, the undersigned, declare that the thesis is my original work under supervision of Nebyou Yonas within Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University, during the year of 2014/15 as a part of Master of Science program in Urban Design and city Development. I further declare this thesis has not been presented in other university, and that all sources of material used for this thesis have been duly acknowledged.

Addis Ababa

2015

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Confirmation

This thesis has been submitted for examination with my approval as a university advisor.

Name: Nebyou Yonas

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Above all, I thank the almighty God because without his assistance my achievements would have been impossible. Many people have substantially helped in many ways to complete this research. I am thankful to all of them. I deeply and truly thankful to my advisor, Mr. Nebyou Yonas, who exhaustively follows this research and invested time to the success of this report. I also thank my family who really scarify their time and resource to the success of my study. Last but not least I thank to my friends, who shares my burden during the whole study time.

ABSTRACT

Node is one of the elements which has important role in the imageability of urban environment or city as well as the development of human centered place. It is mostly characterized by concentration of activities and junction of road where large numbers of people attracted and have good interaction with the place and other people. But in the case of Addis, nodes/junctions are spaces dominated by cars and human need is neglected which have a negative impact on perception and presence of people as well as the image of city. In these research three questions answered including what are problems observed from human need perspective and the perception of pedestrians on diaspora roundabout as well as how to make human centered imageable node. The main objective of the research is to develop human/ pedestrian centered node on case study area that can be adapted for all similar nodes of Addis Ababa. It deeply analyzed the case study area using quantitative and qualitative data collected from primary and secondary data resource through observation, questioner, application of measurements and collected report from different institution. Then those data‘s analyzed through different parameters developed by researchers based on major seven basic needs of pedestrians. In this part different software are applied including GIS, Excel and CAD. Then the analyzed data presented by maps, tables and figures. Those analyses led to certain findings which show the junction is not satisfactory to people‘s needs and need an intervention. In order to solve the observed problems and develop human centered imageable node the research provides different recommendation and design solution.

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Acronyms

AASHTO - American Association of State Highway and Transportation Officials

AACRA - Addis Ababa city road authority

FHWA - Federal Highway Administration

NCHRP- National cooperative highway research program

mph - meter per hour

vpd - vehicle per day

m - meter

Operational definitions

Human centered imageable node – a place which has a capacity to evoke image and fullfill the need of human being basically for pedistrians.

Car dominated roundabout – a type of node classified as junction which is charaterized by presence of high number of cars with fast speed movement and large parking space for cars.

Chapter1. Introduction

Nodes are points, strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he/she is traveling (Lynch, 1960,99). They can be classified into five groups which includes; junction point, transportation hub, activity node, center and city (Lynch, 1960). Lynch‘s theory of urban form (1960) and Bentley‘s responsive environment (1985) identify node as one of important element which enhances imageability of city and provide democratic setting by enriching the place with variety of choice for the users.

Successful node is place where carful decision made has its own identity, defined boundary, related to orientation, and connected with other nodes (Lynch, 1960). It has strong linking street and public relevance activities in the adjacent building (Bentley l. et al. 1985). It is characterized by which includes compact, mixed use and transit oriented development, pedestrian friendly/ walk able environment, provide diversified choice of residence, multi-modal which satisfy diversified need of public, well-designed and high quality public realm and it also integrate, protect and enhance green. Node has different benefit which includes-community benefits, environmental benefit, public health benefit and economic benefit (Regional District of Nanaimo, www.rdn.bc.ca).

There are five basic human needs which include psychological need (for warmth and comfort), safety and security needs (to feel safe from harm), affiliation needs (to belong to a community), esteem needs (to feel valued by others) and self-actualization needs (for artistic expression and fulfillment) (Maslow, 1968). In general those node having a characteristics of successful node and satisfy the basic needs of human being can be defined as human centered node.

Addis Ababa is the capital and largest city of Ethiopia, the country's commercial, manufacturing, political and cultural center (Encarta, 2009). Addis has many nodal point characterized by concentration of activity including services, markets, administration, transportation; junction (place were roads converge) and those having the activity and junction. They have great role in social, economic, physical aspects because they provide services, create job opportunity, generate high amount of income for city from taxes and land rent, attract investors and also connect different areas. This will generate high movement of people and activity from rural and other part of the city to node for different purpose like work, to get different services, to meet people and recreate. But in recent time those nodes characterized by the absence of quality public realm which fulfill the above human need and

the presence of abundant space, high speed flow of vehicle, wide traffic lane and resting place for cars which makes it effective for cars.

This thesis intends to assess problems seen on junction node specifically on diaspora roundabout. Through analyzing the existing situation it develops recommendation and design solution. In generally the major purpose of this thesis is to develop a junction node bounded by quality public realm, dense & mixed use development, public transport oriented & pedestrian friendly environment which satisfy the diversified need of human.

1.1. Problem statement

Recently in Addis Ababa there are nearly 60 roundabouts from these seven of them developed 1930-1945 and used as public place or as node were high number of people attracted and get information, celebrate different ceremonies and interact with other people. But the other ones are just developed after those sevens were designed to accommodate the increasing vehicular traffic happened with the increasing of urbanization. They are place characterized by large space given for road and parking, inhuman scale separated buildings which express individualism, vast open areas without social purpose, segregation of land use, superblock, lack of diversity and connection, social disorientation and privatization of public space (Trancik (1986) and Jacob(1961). In general the main problem that led to this research is absence of human centered node which satisfies need of all kind of people at different status.

Figure 1. Less space and facilities for public and larger space for cars (source; Senait Mohammed, 2006)


Figure 2. Most of roundabout found in Addis Ababa characterized by provision of poor quality public space and low rise commercial development with high vehicular flow (source; Senait Mohammed, 2006)


Figure 3. Roundabout defined by blind fences and lack attractive features (source; Senait Mohammed, 2006)



Figure 4. Dominance of parking and vacant space as well as privatization of public space (source; Senait Mohammed, 2006)

1.2. Research Questions

- What are the major problems of Diaspora roundabout from the basic human need perspective?
- What is the perception of pedestrian on Diaspora roundabout?

- What are the different design strategies that can be adopted to make car dominated Diaspora roundabout a human centered imageable node?

1.3. Objective

1.3.1. General objective

Analyze the problems of vehicle dominant Diaspora roundabout from pedestrian perspective and design human centered imageable node which provides design solution that can be a base for other similar node developments and enhance the imageability of Addis Ababa.

1.3.2. Specific objectives

- Evaluate Diaspora roundabout bases on 7C‘s measurements
- Find out the major problems from analysis
- Adopt other countries successful practices and produce different design solution for roundabout

1.4. Significance

The thesis contributes to a better understanding of node. It is also important to analyze and provide evidence on the existing condition of roundabout in respect to human need and provide a legitimate basis for area where intervention needed. The study also points towards the need for human centered node development strategies to enhance image of the city and also satisfy need of public. It also provides design recommendation for node of Addis. The result can be useful for professionals and also institutions working on road design.

1.5. Selection criteria

The case study area of the research selected based on different criteria which includes; safe type of junction, delineated as mixed use and dense development by structural plan act as transportation nodes and found at center of Addis Ababa. But the area highly characterized by the above written problem. Those criteria are chosen because they are best locations for node development and enhance image of city where the above problem highly observed.

1.6. Scope of research

This research tries to review about junctions of Addis Ababa but geographically it‘s limited to Diaspora roundabout. It cover 11.6 hectare of an area. It‘s selected because

- It has an overlapping character of different node including junction, center, concentration of activity and transport node delineated by structural plan

- It has the potential for development of successful imageable node

- It‘s one of roundabout developed to accommodate increasing vehicular volume

A complete research prepared and inform on case. Then design recommendation also prepared which is important to develop human centered node which enhance the image of city and it can be a base for other node which need design intervention.

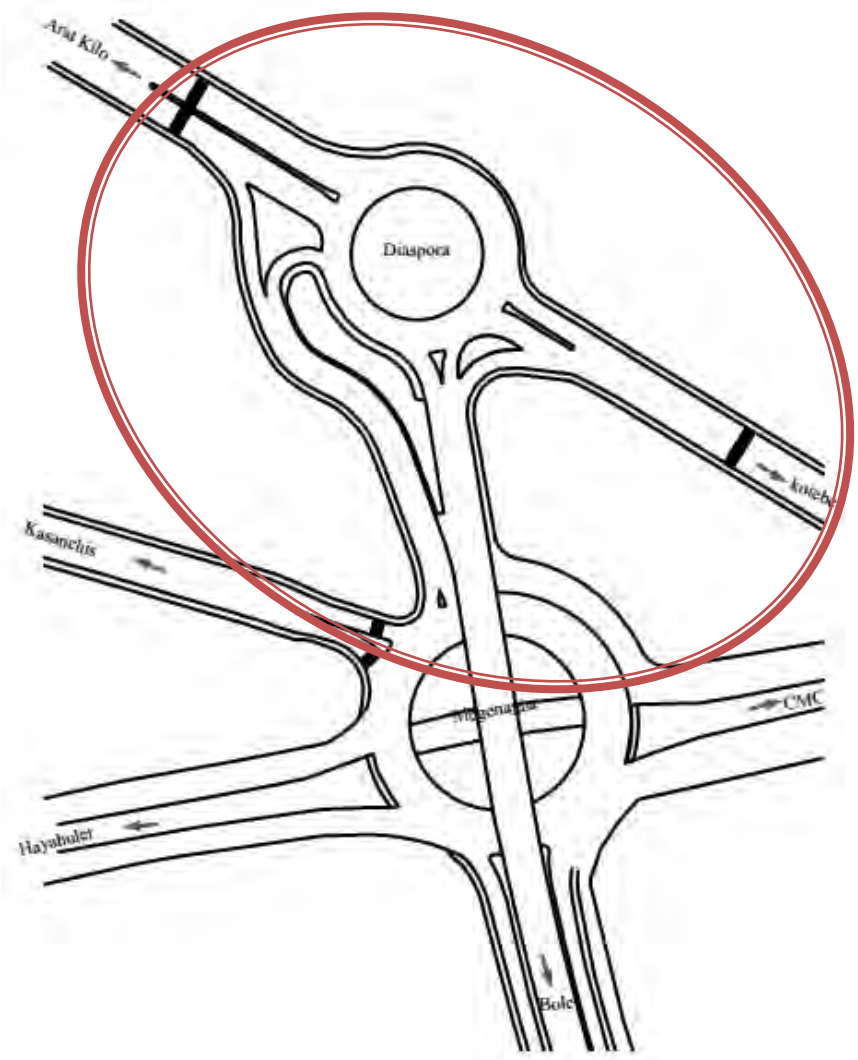


Figure 5. Case study area (source; Addis Ababa structural plan and edited by Senait Mohammed)

1.7. Research Design

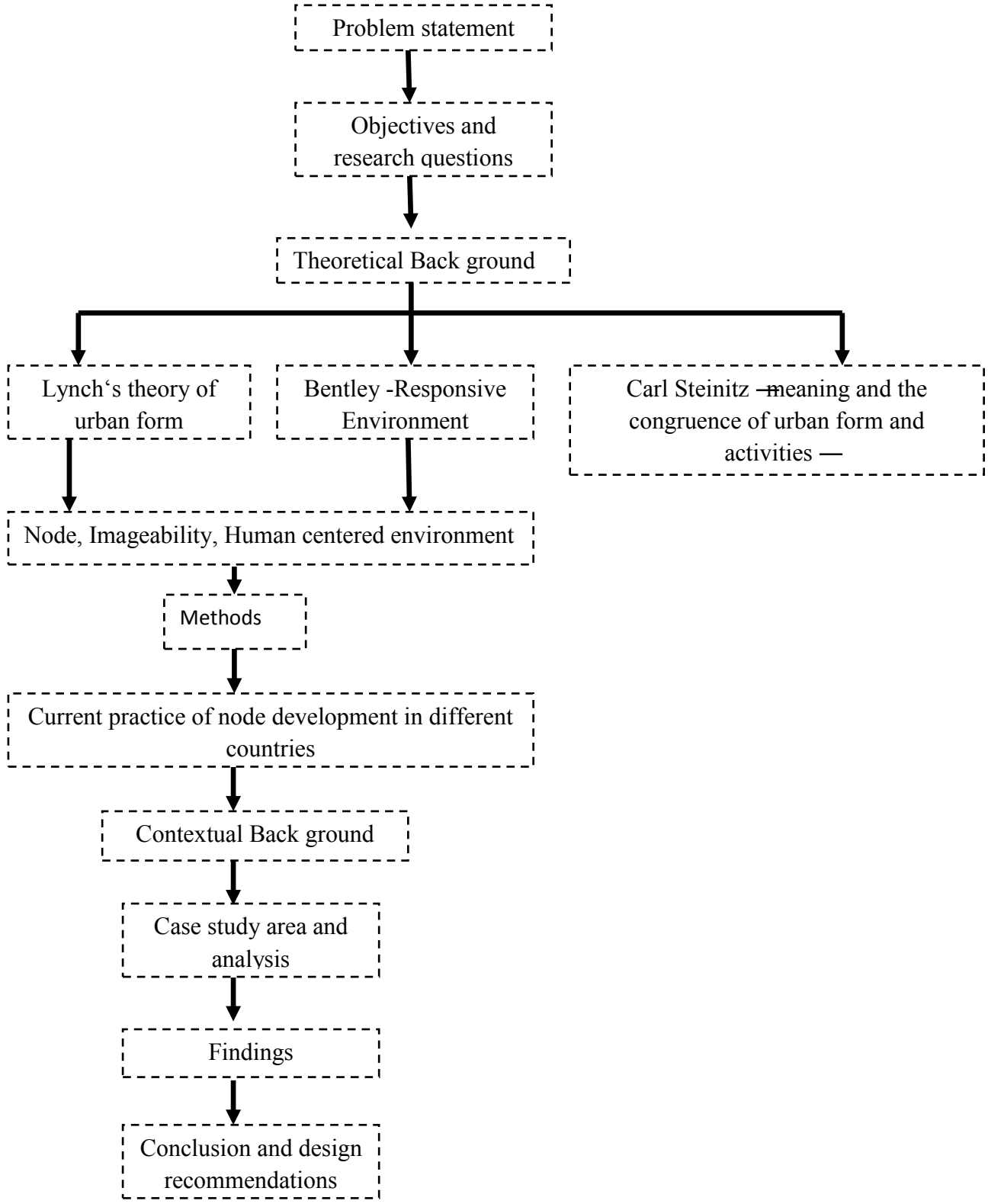


Figure 6. Research design diagram (source: Senait Mohammed)

Chapter 2- Literature Review

2.1. Node

2.1.1. Introduction

These sections of the literature introduce about node including its definition, types, its relationship with other element that are important to imagiability of city, basic characteristics of successful node and different concept which are related to node development.

2.1.2.Definitions of Node

Node is points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he is traveling (Lynch, 1960, 99).

Node refers to ―space of flows‟‟ and ―space of places‟‟ and translated the physical aspect of the meeting of spaces and flows (Castells, 1977). Space of flow is an electronic, computerized network of telecommunication through which most of work of new global economy conducted. Space of place is a physical world of neighborhood and local business nodes within metropolitan region where people live their day to day live and develop personal, familiar relationship and individual identity.

Sitte (1901) and Zucker (1959) define nodes, where major activities occur, where civic buildings are concentrated and where the community lavishes most of its surplus wealth in the form of prestigious development and artistic creation.

A node is a control point or intersection of 2 or more linear systems (roads, railways, information, etc). Nodes are immaterial, representational points that describe flows along these systems (Galloway and Kang, 2000).

In Urban Planning and Design, a node can be a geographic location (neighborhoods, intersections, roadways), a site of activity and interaction (commercial & business corridors, public squares, civic centers, parks), a location of interest that attracts people (historic landmarks, libraries, churches, community centers) and part of a network including other nodes in the urban fabric (links pedestrian pathways, public transit stops, natural convergence of rivers) (Salingaros, 1998).

2.1.3. Types of node

Node can be classified into six types which includes; Junction node, Transportation node, Activity node, core/ city center, square and city (Lynch, 1960, 99).

A. Transportation node

People move from one place to other to carry out different activity using different transportation mode those who use public transportation usually go to specific points in urban space in so-called ‗transport nodes' (Hägerstrand, 1970). It is a place of a break in transportation (Lynch, 1960, 99). It includes bus stops, underground stations or larger structures where several transportation modes come together, such as a central station (Ceccato, 2009).

Transportation nodes should be located to maximize their walking catchment and access by other modes, such as bus, car and bicycle. Major nodes, such as railway stations, will usually be located in centers and can be the focus for the intensification of land uses to take advantage of their high accessibility. Others should seek locations with complementary land uses (e.g. bus stop and corner shop) (NSW Department of Urban Affairs and Planning, 2001). If transportation node is developed at junction of path and node it must be visible and expressive in order to show traveller how he enters the node, where the break occurs, and how he goes outward because of this it will receive more attention((Lynch, 1960).

Public transport nodes/stops should be designed and managed to provide the following: good pedestrian access; safe pedestrian crossings and clear lines of sight to the stop; safe, well designed and comfortable waiting areas with shelter and information on available services; connections between the footpath to the shelter/waiting area and between the shelter/waiting area to the doors of the public transport vehicle, and vice versa; clear identification of the public transport nodes and access points by attractive design and signage; access for all users; bus stops with adequate lighting and shelter as well as public telephones and passive security, such as that provided by proximity to shops and mixed businesses; proximity to commercial and community facilities at major nodes, such as cafes and cinemas, to improve afterhours activity and visibility and safety for public transport users; well-managed precincts around such nodes to optimize amenity and safety; and integration of major nodes with retail and commercial development to form a mixed use precinct (NSW Department of Urban Affairs and Planning, 2001).

B. Activity node

It is a node may be simply concentration, which gains importance from being the condensation of some use of physical character (Lynch, 1960, 99). Activity node is a center of activity (Watson, Plattus, Shibley, 2003: 4.3-3). Urban activity nodes are concentrations of

economic and social activity located at accessible locations such as modal interchanges and the intersections of public transport routes (Mogale city, 2009).

Well-functioning activity nodes are vibrant areas having shopping, work, social and cultural opportunities and public transport facilities in a high quality, safe public environment. The development of dense development with public spaces facilitates large flow of people to nodal area. This will encourage walkability. Such node brings together paths toward public spaces, concentration of activity having symbolic significance and distributed within the community (Alexander, C., and others, 1977; 164-67). Activity node surrounded by a larger district and contain landmark somehow signalized in the surrounding and visible from the outside (Lynch, 1960).

It can serve as the heart of communities and promote social interaction; it can serve multiple neighborhoods; sharing of facilities between various services can take place; it enhances accessibility and convenience for residents (Mogale city, 2009).

C. Squares

The square or piazza is a place of rest within the busy street network. In the terms of Lynch (1960) it is a node of activity, the junction of many paths: it is the center or the portal of a district, town or city. As such the node is a place where people gather and rest before continuing the journey (Moughtin,C, T. and Tiesdell, S.,1995). These spaces may be places for socializing, hosting the greatest number of people‘s interactions (Tibbalds, 2003). It is the natural setting for the most important civic and religious buildings, a place for fine sculpture, fountains and lighting and, above all else, a place where people meet and socialize (Moughtin, C., 2003). Locating civic squares at active transport nodes in activity centers is important for successful square (NSW Department of Urban Affairs and Planning, 2001).

There are five types of square which include; the closed square where the space is self-contained; the dominated square where the space is directed towards the main building; the nuclear square where space is formed around a center; grouped squares where spatial units are combined to form larger compositions; and the amorphous square where space is unlimited (Moughtin, C., 2003).

The quality of the design criteria that make squares significant is categorized into activities, comfort and safety, form and size of square, location, accessibility, Visual complexity: visual and aesthetic elements(seating; hard and soft landscaping; street furniture; shelter and protection (microclimate); subspaces; lighting, human scale and public art (Zeka, 2011)). In addition to above ones meaning, Control and participation,

publicness as well as natural systems and environmental quality are other criteria‘s (Cooper and Francis, 1998: 90). The most important physical quality of successful square is enclosure (Moughtin, C., 2003).

Numerous researchers have made advices regarding the perfect measurements of a square (Krier, 1979; Lynch, 1992; Zakri, 2008). Kevin Lynch (1992) suggests measurements from 12 meters (instead of an close scale) to 24 meters (a satisfying human scale) beside every face, and increases to 100 meters for big squares (similar to the dimensions of effective historical enclosed squares which is not more about 100 meters; medieval squares had average dimensions of 57x140 meters). Jan Gehl (2011) identifies similar highest dimensions of 70 to 100 meters and sets the tallest distance to realize the facial looks as about 25 meters; Christopher Alexander represents that the measurement of a small square should be 22 meters crosswise at most (Childs, 2006; Gehl, 2011; Shaftoe, 2008). If the space is too large people tend to linger along the edges and do not interact with other users as much (Gehl, 1987).

Squares must be well defined and enclosed by buildings, strong sense of connection between the urban square and the ground floor of surrounding buildings, informal activities or small retail offerings that attract people to linger longer in a space; active (day and night time) uses; quality formal and informal seating and lighting contribute to identity and character; planting trees to enhance the attraction and character of a space by providing shade and good access; public art to attract visitors and provide a memorable icon for the space; and a range of event based activities to occur within the space will foster social capital and increase levels of activity(NSW Department of Urban Affairs and Planning, 2001).

Squares are public space which creates ―interactive relationship" between people‘s activity and the physical structure of a space (Frick, 2007). On the other hand, they offer many other interactive opportunities simultaneously, including communication paths, vibrant trade, social interaction context or a venue for political events (Pugalis, 2009). Tibbalds (2003) points out that public space is the most important part of the cities as presents ―public life", ―civic culture" and accommodates the human interactions.

Urban Public spaces have several types of value (Varena and Tiesdell, 2010). As public spaces provide an environment for social interaction as well as political displays and actions they introduce political and social dimensions. Moreover, public spaces are the representative of symbolic values of particular society. Therefore, ―symbolic presentation" of public spaces is another value dimension in the public realm (Jacob and Hellstrom, 2010). Considering these three main values of public spaces, Jacob and Hellstrom (2010) develop the dimensions of

public space values that can be categorized into: leisure and play, power and organization, utilities and change and Identity and unity.

D. City

When conceiving the environment at a national and international level, then the whole city it may become a node (Lynch, 1960, 99). City is largest level node and product of the above node. Cities have always been regarded as the fulcrum of human communication, the place of possibilities and opportunity, either economic or political (Graham and Marvin, 1996).

Cities are nodes of man‘s greatest impact on nature, the places where he has most altered the essential resources of land, air, organisms, and water. The city is the quintessence of man‘s capacity to inaugurate and control changes in his habitat. Through urbanization man has created new ecosystems within which the interactions of man, his works, and nature are complex. This complexity—and the importance of our understanding it—grow as cities burgeon in the modern world (Melvin G. Marcus and Thomas R. Detwyler, 1972).

City is a theater of social actions and everything else- art, politics, education, commerce serve only to make social drama more richly significant as a stage set, well designed, intensifies and underline gesture of actor and action of play (Mumford, 1969).

According to Dixon (1996) there are critical conditions, which are common to all cities:

1. There is an unprecedented increase in population due to improved living conditions, accompanied by a migration to urban settlements. The result is growth of urban settlements at a tremendous scale.

2. We experience multiple impacts of machines in our lives. These impacts lead to higher productivity and new possibilities, but also bring unprecedented problems to the structure of cities and society, of resource use and environmental degradation.

3. There is a gradual socialization in the patterns of living, which allows the whole population to participate more and more in the city, its facilities and resources.

4. In the modern city, growth and change over time is a dominant feature, which must take precedence in all planning considerations.

City can be improved through improvement of streets as public spaces; create squares and parks as multi-use destinations; build local economies through markets; design buildings to support places; link a public health agenda to a public space agenda; reinvent community planning; power of 10; create a comprehensive public space agenda; and lighter, quicker,

cheaper: Start Small, Experiment and Restructure Government to Support Public Spaces (UN-HABITAT, 2012).

The degree of good city performance is determined by its ability of providing biological, psychological, social and cultural requirements to its inhabitants. Once these requirements have been specified, then estimation could be made offering to which degree the city is good. Kevin Lynch in his book *good city form* summarized these requirements in five points, they are called performance dimension:

Vitality **-** The degree to which the city sustains the essential, biological performance of human beings: this is the supports of our bodies needs such as water, air, energy and food, there should be sufficient supply of them to sustain life, moreover good settlement should be free of danger, poisons and disasters, then it supports safety for its inhabitants.

Sense **-** It is the degree of fit between the physical city (form) and the way people recognize and organize it in their minds. In other words, it is the degree of homogeneity between environment and observer. Sense then, reflects the clarity with which people perceive the space. Sense depends upon spatial structure, quality, the culture and the current purpose of the observer (Lynch, 1981). Sense can be broken into six elements;

a. Identity **-** It is the character and spatial attributes of an object or a place that enhance the ability of recognizing and identifying an environment, those attributes of the object make it distinct, ultimately unique and easily separable, then it stands for individuality or oneness (Lawson, 2001).

b. Structure**-** It is how the object is placed in the space considering its relation to the observer and to other objects, as the object is not seen isolated from surroundings but as a part of all environmental components. –The architect has to realize that the forms of his buildings react on adjacent forms" (Moughtin, 2003: 28). Norberg-Schulz and lynch refer to organization when they talk about structure.

c. Meaning – it is that which the place stands for or represent (Lawson, 2001). Steinitz (1968) made an inference that the city becomes more meaningful and known to its inhabitants when there is congruence between its physical form and activity (Broadbent et al., 1980).

d. Congruence **-** It is the relationship of the form to its function. In other words, how is the environmental structure congruent with non-spatial structure.

e. Transparency (Immediacy) - It stands for the degree of visibility of process occurring in the place to users.

f. Legibility **-** It is the term that has been used for a long time in urban planning defined as ―the ease with which its parts can be recognized and organized into a coherent pattern" (Lynch, 1960). According to Lynch definition, legibility can enhance the identity, structure and the meaning of environmental surroundings.

Fit **-** It is the match between the action (function) and the physical city (form), this is the requirements of our culture. It is ―how well the spatial and temporal pattern of a settlement matches the customary behavior of its inhabitants" (Lynch, 1981: 151). When there is congruence between form and patterns of behaviors, people feel comfortable; conversely, absence or lack of fit could make it uncomfortable and difficult to behave through an area.

Accessibility **-** That is not means the ability to reach transportation only, but to access to all things such as services, information, and other places and to other peoples also, and then an interaction is established between these variables. Access offers the degree of choice and diversity presented to us. A place should provide people with information about physical ways of reaching it.

Control **-** It the degree to which the environment is under the control of the people who actually use it or reside in it. According to Hall, control gives people feelings of power and stability. People feel in control when there is enough social and physical space to do as they need.

E. Core/ center of city

It is a node which has the nature of both junction and concentration (Lynch, 1960, 99). Centers are mixed-use areas which include jobs and housing as well as services, entertainment, retail and civic uses. Centers are the focal points and destinations within the Regional City. They gather together neighborhoods and local communities into the social and economic building blocks of the region. Centers are primarily retail, civic and workplace dominated with some residential uses mixed in. They are the destinations of several or many neighborhoods (Watson, D. Plattus,A. Shibley,R. 2003).

F. Junction nodes

Junction nodes occur automatically at major intersections and termini and by their form should reinforce those critical moments in a journey (Watson, Plattus, Shibley, 2003: 2.9-7). Junctions are generally places of interaction among street users and also for the development of important building and functions characterized by high accessibility and good natural surveillance other than traffic handling (Telford, 2007). They provide a point of entry, define a place and act as a landmark (Telford, 2007)**.**

Successful junction has a recognizable identity defined by the buildings or spaces around it. So junctions must have to serve as a place other than movement. The successful development of junction dependent on how the building arranged and creates enclosed space (Telford, 2007).

When junctions are designed a designer should have to touch issues like traffic priority arrangements, the need for signs, markings and kerbs, and how property and building lines are related. Junction design should facilitate direct pedestrian desire lines, and this will often mean using small corner radii (Telford, 2007: 84).

―When we consider more than one path, then the path intersection becomes vital, since it is the point of decision" (Lynch, 1960: 57). Lynch mentioned that perpendicular angle of an intersection is the easiest to handle, as this right angle reinforce the simplicity of the shape of that intersection. Indeed, there are two structural factors that seem to control the ability of recognizing a particular intersection; they are number of points and types of angles that tie these points. In other words, crossing of more than four points and different types of angles always cause locational difficulties. But this is not all the story, as there may be clear perpendicular, three-pointed crossing with confusion of intersection, this may refer to the shapelessness of that intersection, thus failing to communicate its structure (Lynch, 1960).

The main objective of intersection design is to facilitate the convenience, ease, and comfort of people traversing the intersection while enhancing the efficient movement of motor vehicles, buses, trucks, bicycles, and pedestrians. Intersection design should be fitted closely to the natural transitional paths and operating characteristics of its users.

There are seven types of junction layout which include T junction, Y junction, cross/ staggered junction, multi armed junction, square, circus/ roundabout, and crescent junction (Telford, 2007)(see table 1).

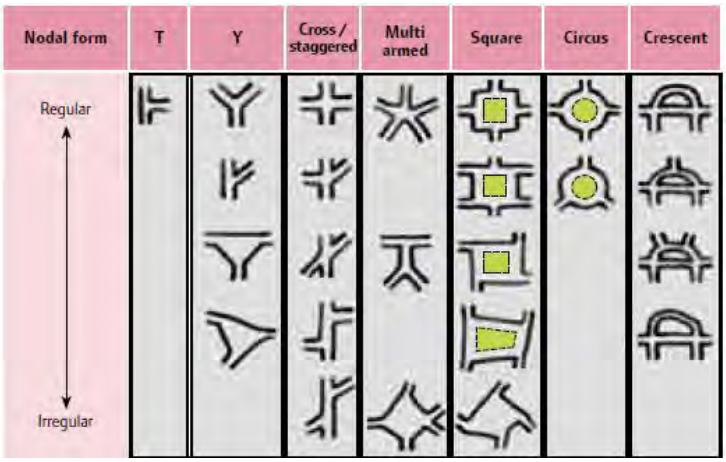


Table 1. Type of junction (source: Telford, 2007)

Roundabout- is a channelized intersection at which all traffic moves anticlockwise around a central traffic island (AACRA, 2003). Roundabouts must be designed to meet the needs of all users—drivers, pedestrians, pedestrians with disabilities and bicyclists. When designing roundabouts, special considerations must be given to the needs of pedestrians with visual disabilities who are unable to judge adequate gaps in traffic at roundabouts. Proper site selection and pedestrian channelization are essential to making roundabouts accessible to all users. Roundabouts can also be designed for trucks and larger vehicles and in geographic areas where significant snowfall is the norm during the winter (FHWA, 2001).

There are different elements take into consideration during roundabouts design including: design of vehicles, design speed, sight distance, deflection, central Island, circulating width, inscribed circle diameter, entry and exit design, splitter Island, super elevation and drainage, pavement markings, signage, lighting and landscaping.

Roundabout is important to achieve slow entry speed, appropriate number of lanes, smooth channelizing, adequate accommodation of design vehicle, meeting need of pedestrian and bicyclist, appropriate sight distance and visibility. FHWA recommends it as proven safety countermeasure through reduction in vehicle speed, reduction in conflict point and improve crash and injury rate. Roundabouts have a lower overall delay than other controlled intersections in typical conditions. It‘s performance affected by driver behavior.

Roundabout has eight major components which include yield control, circulatory roadway, central island, pedestrian access, splitter island, yield line, landscaping buffer and accessible pedestrian crossings.

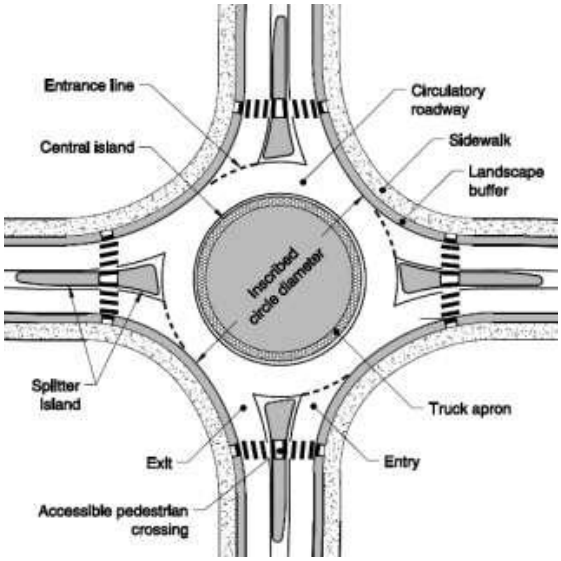


Figure 7. Features of roundabout (source: AACRA, 2003)

There are three type of round about including mini roundabout, single lane roundabout and multiple lane roundabouts.

Mini roundabout - It consist maximum desirable entry design speed of 15-20 (mph), maximum one entry lane, inscribed circle diameter 45-90 feet, fully traversable central island treatment and maximum daily volume up to 15000 vpd.

Single lane roundabout- It consist maximum desirable entry design speed of 20-25 (mph), maximum one entry lane, inscribed circle diameter 90-180 feet, raised(may have traversable apron) central island treatment and maximum daily volume up to 25000 vpd.

Multiple lane roundabout- It consist maximum desirable entry design speed of 25-30 (mph), greater than equal two entry lane, inscribed circle diameter 150-300 feet, raised(may have traversable apron) central island treatment and maximum daily volume up to 45000 vpd.

According to FHWA (2000) there are six major benefits of roundabout which includes; reduction of accident and enhancing safety, slower vehicle speeds (under 30 mph), efficient traffic flow, reduction in pollution and fuel use, lower cost, traffic calming and aesthetically pleasing landscaping.

According to NCHRP (2007) roundabout also has disadvantages which includes; pedestrians with vision impairments may have trouble finding crosswalks and determining when/if vehicles have yielded at crosswalk and also bicycle ramps confused with pedestrian ramps; safety problem (Increase in single-vehicle and fixed-object crashes); in respect to operations it gives equal priority for all approaches this can reduce the progression for high volume approaches and cannot provide explicit priority to specific users unless supplemental traffic control devices are provided; reduce the number of available gaps for midblock unsignalized intersections and driveways, it affect the environmental due to greater spatial requirements at intersections, it need more expensive traffic Calming treatments; it often require; require landscape maintenance; and create a safety hazard if hard objects are placed in the central island directly facing the entries.

G. Pedestrian Nodes

Pedestrian nodes are points where pedestrian related amenities are grouped to increase the perception of an active, urban corridor and to encourage more walking, bicycling, and transit use. Amenities may include shade-oriented bus shelters, seating, drinking fountains, landscaping, public art, information displays, and bicycle rest stops. Not all locations require all amenities (Comprehensive Planning Task Force, 2001).

Pedestrian nodes are important because it give emphasis on alternative mode use in the corridor, contribute to the ―greening" of the corridor, provide ―true" shade during the hottest

months, and contribute to the overall vibrancy, safety, and desirability of the area. These nodes should occur where single uses or a combination of uses lead to higher levels of pedestrian activity. (Comprehensive Planning Task Force, 2001).

Pedestrian nodes should be located where higher pedestrian densities exist or are forecasted. Such locations may include high-use bus stops or transfer points, schools, larger multi-use complexes, and active retail areas.

According to Comprehensive Planning Task Force (2001), when designer develop pedestrian node it has to provide the following aspects;

1. A combination of street trees and node trees to create a dense canopy of shade;
2. Shrubs and groundcovers protected from pedestrian traffic, either by their location or by a strong definition of pedestrian spaces vs. plant spaces.
3. Variety of uses to increase the density and activation of the space. High use and extended hours of use of these pedestrian nodes will increase the perception of urban environment.
4. Furnishings such as drinking fountains, trash cans, and benches to increase the users' sense of comfort. Seating should be arranged to accommodate groups of 2-4 people and should be shaded from the afternoon sun. Careful thought should be given to the amount of seating provided because too much unused seating may detract from the goal of creating an active urban area.
5. ~~–a~~rt rails" (i.e., customized guardrails), walls, and other elements as needed to meet engineering safety standards. These elements should be designed to accentuate a neighborhood's identity and contribute to the overall sense of a cohesive corridor.
6. Accessibility to people with disabilities in compliance with the Americans with Disabilities Act.

2.1.4. Relationship between node and other elements of city image

Node has some characteristics of other elements of city including path, district and edge which has role in the imagiability of the city.

Node/ path **-** node is related to path, since junctions are typically the convergence of paths, events on the journey (Lynch, 1960).

Node/ district **–** node is related to district, since cores are typically the intensive foci of districts, their polarizing center (Lynch, 1960).

Node/ landmark **-** node is a type of landmark but is distinguished from a landmark by virtue of its active function. Where a landmark is a distinct visual object, a node is a distinct hub of activity. In any event, some nodal points are to be found in almost every image, and in certain cases they may be the dominant feature (Lynch, 1960).

2.1.5. Successful node

Nodes can be recognized even when they are shapeless, but when supported by a strong physical form, then they become memorable (Lynch, 1960). Good recognizable node should has its identity through singularity and continuity of walls, floor, planting, lighting, topography, silhouette, function, clarity of shape and intensity of use. Location determines nodes utilization, as locating nodes on main routes make economic movement more efficient than those located away from. The most successful node has distinct character and also capacity of enhancing the surrounding environment. During the designing of successful nodes every designer should have to provide node which has its own identity, defined boundary, and place were a carful decision made, bounded by district, visible & expressive, contain landmark related to orientation, and connected with other nodes as well as elements of image (Lynch, 1960). Its success depends on functional role of linking street and level of public relevance activities in the adjacent building (Bentley l. et al. (1985)).

*Great Street***;** Accessibility, social interaction, publicness, livability, safety, comfort, participation and responsibility are important criteria required by a great street from social and economic perspective. Great Street provides function of accessibility, comfortable, safe and pleasing movement with experience of city. People come into this area either to be seen or to see. The size of walkways of such street is depending on what people accustomed to, reason for walking and nature of street. If it provides fewer amounts of walkways it led to overcrowded environment which led to reduction of speed, safety and security. A great street will provide space where people walk and also interact with environment visually and physically if it has comfortable environment, strong defining element, quality which engage eyes, transparency, complementarity, maintenance and quality of construction and design (Jacob, 1993).

Reinforce Nodes- in order to strength nodes first the position of all junction and uses in building around them have been fixed. Then decide which junction need special reinforcement and how should be done All junction are potential node but they should not all given equal significance. Appropriate degree of emphasis and each node depend on three factor- functional role of street forming function- as role increase it will have great emphasis; activities in

adjacent building – more publicly relevant great emphasis; expectation set by other node within district concerned (Bentley l. et al. 1985).

2.1.6. Advantages of node

As complete, compact communities, nodal developments have a number of social, environmental, health and economic benefits (Regional District of Nanaimo, www.rdn.bc.ca). It encourages walkability through provision of different facility with close proximity which results in cleaner air, revitalizes community life by helping streets, public spaces and pedestrian-oriented retail to become places where people meet, shop and gathers and enhances security of an area by increasing the number of people on the street, support dense development which can reduce infrastructure servicing costs, reduces sprawl and traffic, and preserves and conserve precious environmentally sensitive areas, recreation areas and greenways, and agricultural lands. It also has substantial fiscal and economic benefits for municipalities (generate tax), developers, community businesses and residents (employment). It also solves problems related to traffic, noise, and public safety, marketing and sales through street design, keeping parking to rare/ underneath of building, transportation demand management, through building placement, vegetation and architectural design, compact mixed development and their eyes on street.

2.1.7. Concept related to node development

A nodal development is a complete, compact, mixed-use community that includes places to live, work, learn, play, shop and access services. These communities are called nodal developments because they act as nodes, or hubs, for both the residents living in the center itself and for people in nearby communities. Like old-fashioned village centers, good nodal developments include a mix of residential, commercial and service elements in a small, walk able area. They are linked to surrounding areas by transit, bicycle and pedestrian connections so that people do not have to rely on using a car to get around. Nodal Development is one of many names used to describe this concept. Other terms include: smart growth development, compact mixed-use (new urbanism, main street development), town center development, transit oriented design and urban village (Regional District of Nanaimo, www.rdn.bc.ca).

Smart growth is a planning concept developed in USA in 1970 and well accepted 1990 as a means of addressing urban sprawl that promote holistic development that mixes housing, employment, retail and other land use whilst preserving meaningful open space and other environmental asset(Smart Growth Network, www.smartgrowth.org).

Principles of smart growth - accessibility are key features of smart growth which underpin the focus on community, economy, and environment. The other characteristics are; encourage collaboration of stakeholder in decision making, take advantage of environmentally sensitive compact building design, ensure land use is appropriate and that development use sites to maximum advantage, relate development density with accessibility, create a range of housing choice, deliver workable neighborhood with strong sense of place, preserve and enhance open spaces, natural features and environmental sensitive areas, strength existing communities through provision of service and opportunities to wider community, enhance accessibility choice through mobility choice, make development decision predictable, fair and cost effective (Craig W. Kelsey, www.play-safe.com).

Urban village concept introduced in 1992 by urban design group in UK which envisage as a settlement which is small enough to create a sustainable community. It can be created on greenfield or brown field site and will be dense developed in the center with density easing away from the central hub Transit Villages (www.transitvillages.org).

Principles of urban village- mixed use neighborhood, 1;1 ratio between job and residence, compact development within a maximum 10 min walk across(900m) and designed around the principle of pedestrian having priority, population of around 3000- 5000 person, development should be high density, the development should incorporate environmental friendly design, housing must be provided with mixed tenure and level of affordability to ensure a well-balanced socio- economic mix, public transport should be provided to ensure sustainable transport option are available, there should be strong sense of place and identity (Transit Villages www.transitvillages.org).

New urbanism concept is related to conservation development and TND. It is essentially a strand of compact settlement design which aims to minimize urban sprawl and provide sustainable settlement (Urbanism, T. c., 1996).

Principles of new urbanism- walkability through provision of most things within 10 min walk of home and work, pedestrian friendly street design by placing hidden parking, building close to street, slow speed streets, connectivity through application interconnected street grid network, a strong street hierarchy, and focus of providing a quality pedestrian network and public realm, mixed use and diversity through mixing of functions/ activities within neighborhood/block/building and diversity of people of age, income level, culture and race, mixed housing having different size, type and price in close proximity, quality architecture and urban design emphasis on beauty, aesthetics, human comfort and creating sense of place,

and human scale, TND(discernable center and edge ,public space at the center, importance of quality public realm, contain a range of use and density within 10 min walk, transect planning highest density at town center), increased density by placing more building, shop, service, residence close together for easy of walking to enable a more efficient use of service/resource and to create more convenient , enjoyable place to live, smart transportation by networking of high quality train connecting cities, towns and neighborhood, pedestrian friendly design which encourage cycling, rollerblades, scooter, walking as a daily transportation, sustainability with minimal environmental development impact and its operations energy efficiency and eco-friendly principle, quality of life that can enrich, uplift and inspire the human spirit) (Urbanism, T. c., 1996).

Transit-oriented development (TOD) is characterized by two main features: proximity to and a functional relationship with transit stations and terminals and service provision by high-quality public transit (BRT systems, underground trains, and so forth) as well as compact, mixed-use buildings and neighborhoods that, because of their design, encourage walking, cycling, and use of public transit by residents, employees, shoppers, and visitors (HDR | SR Beard & Associates, 1950).

The ingredients of successful TOD include strategic (macro) and design (micro) elements such as a strong development climate and master plans for multiuse, high-intensity developments supported by implementation plans. They also include investments that promote the following: easy and direct pedestrian, bicycle, and public transit access, good signage and a pleasant environment to attract substantial pedestrian flows, significant regional accessibility to major job and activity centers , short, direct connections between transportation modes and transit facilities, bicycle lanes and parking facilities that feed stations, attractive facilities that are well integrated with the surroundings (public spaces, street furniture, and so forth), safe and secure designs, including adequate lighting, effective parking management around stations , environmentally friendly technology options, such as shared fleets of alternative (electric) vehicles located in neighborhoods (Cervero, R., 2008).

2.1.9 conclusion

Node is a center of attraction everyone can access and interact with environment. It can be classified into building, square, junction node, activity node, transportation node, center, city and pedestrian node. It is appropriate if it is located within a walk able distance and at center of city where important path meet and accessible to public transport. Its success is depend on its accessibility, connectivity, comfort, safety, attractiveness, mix of use, density, diversity,

enclosure, vitality, sense, permeability, fit and control. So every designer need to consider those aspects. Node is also important for the sustainable development of city. Roundabout is one type of node recently developed which classified as junction node. In the development of node different concepts are developed which includes smart growth development, compact mixed-use (new urbanism, main street development), town center development, transit oriented design and urban village. Those concepts are contemporary concept applied by different countries. In general node is important element of city if it‘s properly designed from human perspective.

2.2. Imageability

2.2.1. Introduction

This section of the literature review critically examines imageability, to understand its meaning, need and uses for the city and its dwellers. The different elements of an image also discussed. The different classifications of image and the parameters to measure imageability are listed out along with strong cues for imageability.

2.2.2. Definitions

The word ‗image‘ has different meanings for different people; it is a kind of experience and may be a concept, plan, map and so on.

Imageability, the term coined by Lynch Kevin (1960), ―is the quality of a physical object, which gives an observer a strong and vivid image and also called legibility.”

An Image also refers to memory and this has become dominant in planning and urban design (Lynch Kevin 1960, Carr. and Schissler, 1969).

An image is an internalized representation and, regarding the environment, it is ―an individual‘s mental representation of parts of the external reality known to him via any kind of experience”, including indirect experiences (Downs and David Stea, 2005).

An Image stands for a notion, stereotype, plan or map, plan of action, concept, self-concept and so on (Rapoport Amos, 1977).

By critically analyzing the different definitions of imageability by different pioneers in different periods, the definition of an image which refers to memory, a dominant concept of planning and urban design, as the point of contact between people and their environment, is adopted in this research.

2.2.3. Different Elements of an Image

Lynch Kevin (1960) has identified five important elements of imageability including paths (familiar routes followed), landmarks (point of reference), nodes (centers of attraction that we can enter), districts (areas with perceived internal homogeneity) and edges (dividing lines between districts). The uniqueness of the design and meaning of these elements helps enhancing the imageability, helps to make things noticeable and can be shared by groups. Associations of different elements are generally unimportant; the location of physical elements is more important than their appearance.

2.2.4. Imageability Need and Uses

According to Harold Carter 1976 City image enhances the legibility of the city, increases the aesthetic pleasure which is related to the quality of the images of the city, it enhance the scale of efficiency for the ease with which people can get about, with which motorists can find their way which is closely related to its legibility, that is, on a small scale these qualities become related to any single building but for the city it depends upon the organization of different city elements, they reveal the images of the city to the everyday user and therefore also indicate the existence of major problems. Deficit of imageability means less identification and is an indicator of the social and economic value of the city.

2.2.5. Parameters to Measure Imageability

Rapoport Amos (1977) identifies the parameters to measure an image under the overall satisfaction with places, which is related to three major characteristics.

I. Identity - The ability to identify with a home area

II. Accessibility - Accessibility to desired places, people and services and

III. Physical Setting - A physical setting corresponding to the image of an ideal environment

There are different imageability parameters identified by various pioneers for the physical components in measuring an urban area with respect to Identity which includes; the physical components of the image of a Residential area and Neighborhoods, location, type of housing unit, attractiveness, access to parks, housing maintenance, density, noise, adequate outdoor space, privacy, low traffic level, trees, clean air, topography and view, up keep of area, streets, spaciousness, beauty, quietness, physical quality, harmony with nature, variety and richness, materials and style of dwelling, traditional appearance, variation in architecture, distinction of front and back, spaciousness, beauty, country like character, low density, privacy, front and

backyards, greenery-large shade trees, quiet, newness and cleanliness, wide spacing, purely residential, views from the living room, general appearances and noise.

There are different imageability parameters identified with respect to the physical setting including building/ built space, open space (urban space and recreational area), street and special district. It described as follow

Buildings- total massing, levels of complexity, scale and size, orientation, building height, building use, color, materials, details, fenestrations, signs, activity levels, noise level, light level, smells, maintenance and cleanliness, landscape etc.

Open Spaces- Degree of enclosure, size of space, character of space, nature of enclosing elements and amount of greenery, scenic beauty, visual quality-signs, distinct districts, orientation, air quality and weather, transportation etc.

Streets- Spatial quality, intrinsic interest of feature, specific buildings, nature of traffic and parking (Lynch,1970); elimination of utility poles and overhead wires more important than elimination of billboards; signs to enhance legibility and orientation; traffic hazard, noise, vibration, pollution and trash, maintenance, privacy, greenery, complexity, variety, spaciousness, clean air, microclimate, and topography and view.

Special Districts-Natural preferred to artificial, variety and contrast; Natural character, views without obstructions, special dislike utility poles; Maintenance level, low pollution, noise at night, traffic disliked, ownership and identity of house, detached houses, low density, openness, spaciousness, greenery, hilliness and views; Rural character or desirable older central areas, topography, proximity to water; General appearance of each area, elevation or apparent elevation, extensive views of water or trees but no industries, detached houses, newness, greenery, spaciousness, individuality

2.2.6. List of Cues for Strong Imageability

Further, cues from which people choose to make a place more ―distinguishable" lead to strong imageability. This list of cues is with respect to the physical difference, social difference and temporal difference. The most important cue from which people choose to make a place more distinguishable, and which leads to strong imageability is the physical difference which include vision (objects, space quality, light and shade, greenery, visual aspects of, perceived density, new vs. old, order vs. variety, well maintained and badly

maintained, scale and urban grain, road pattern, topography and location), Kinesthetic (change of level, curves, speed of movement), sound, smells, air, movement, temperature and tactile.

2.2.7. Quantitative and Qualitative Parameters of Imageability

In continuation of identifying the imageability parameters under different characteristics of the urban area, they are further grouped into two.

The quantitative Parameters and cues from which people choose to make a place more ―Distinguishable"- leads to strong imageability with strong identity and Physical setting (Rapoport,1977) which include adequate outdoor space, trees, clean air, physical quality, harmony with nature, amount of greenery, nature of building elements, signs, noise level, degree of enclosure, character of space, nature of enclosing elements, transportation and parking, access to parks, safety and comfort, street length and proportion, paving and street furniture, nature of ground floor abutting the street, building height, building use, color, materials, fenestrations, appearance & elevation, type of housing units, density, style of dwelling, variety, total massing, levels of complexity and orientation.

The qualitative Parameters and cues from which people choose to make a place more ―Distinguishable"- leads to strong imageability with strong identity and Physical setting include beauty, country like character, privacy, newness and cleanliness, view from the living room, richness, appearance, distinction of front and back, attractiveness, activity levels, smells, visual quality-signs, distinct districts, topography and view, natural character, views without obstructions, traffic disliked, newness and individuality.

2.2.8. Conclusion

Image is a metal map printed on human mind because of his/her attachment to the high quality environment having meaning. There are different clues that show strong imageability but physical difference is the best one. It is important to increase aesthetic pleasure, scale of efficiency, legibility and to reveal image of city. It has three components (identity, structure and meaning) and five basic elements node is one of them. It can be measured qualitatively and quantitatively from perspective of identity, accessibility, physical setting and other characteristics of urban.

2.3. Theories related to node

2.3.1. Introduction

These section will introduced different theories developed on node importance in imagiability of city and also for development of human based environment which includes

Lynch –theory of urban form", Bentley –responsive environment" as well as the other theory of carl Steinitz –meaning and congruence of urban form and activity" which contradict it's importance.

2.3.2. Lynch's theory of urban form

In Lynch's book 'Image of the City' (1960) he introduced the theory of urban form. An urban environment is a complex system of interactions between people (users) and various surrounding objects. Lynch described two things important for a subsequent explanation of the whole theory: first, physical elements of the city and second, the psychological, mental image of the city. Lynch distinguished physical elements into natural (exist in nature that man uses and interpolates in his 'built elements') and man-made elements (static or dynamic objects). Altogether, natural and man-made elements are characterized by common characteristics, such as color, smell, noise, warmth, and so on, which build a perceptual form of the urban environment. The visual quality of the urban environment, in Lynch's theory, relates to the physical elements of the environment and the mental image of its users. Users perceive an urban environment in its fragmentation into elements and patterns. All perceptions are different and special, and are related to users' knowledge, experience or familiarity with an urban site. Almost every sense is in action all of the time. The visual qualities of some elements and features are used as generalities in the process of navigating in the urban environment. Lynch considers the visual quality of the city "by studying the mental image of that city which is held by its citizens." The visual quality of the city is concentrated in four elements in Lynch's theory: legibility, building the image (image), structure and identity (identity) and imageability. Lynch also analyzed the effects of physical, perceptible objects, and from this the five elements of the urban environment were derived. In his theory he does not explain all other influences of an urban environment on imageability, such as social meaning, functionality, tradition, names, and so on. The five elements derived from the analysis of urban objects in Lynch's theory are: paths, edges, districts, landmarks and nodes. Nodes are points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he is traveling, they may be primarily junctions, places of a break in transportation, a crossing or convergence of paths, moments of shift from one structure to another.

2.3.3. Carl Steinitz "meaning and the congruence of urban form and activities "

Lynch's theory received criticism in a paper written by Carl Steinitz –meaning and the congruence of urban form and activities –.reinforcing his criticism by the words of Gulick

Who says that ―people do not imagine cities in terms of nodes, landmarks, and so on". Instead, he says that ―image ability has its significance in the mind of the beholder". In another word, image ability is determined by the beholder's perception of the visible form of an object combined with his consciousness of some social or behavioral which he associates with it.

Steinitz believes that the urban form and for efficient human activity within a city, the following conditions should be clearly expressed:

(a) The type of activity it contains

(b)Relative ―intensity" of the activity in question to others adjacent activities.

(c)It's significance.

Steinitz attempts to achieve congruence through similar methods assumed to be used unconsciously by residents in their perception of their city. This fundamental point is levied by Steinitz against the lynch approach where people are supposed to be aware of modes….and so on. From the previous three conditions Steinitz formulates the theory that consistency or congruence between the independent variables of an environment which form activity and perception should result in an environment of minimal representation images and relationships which allows the individual to absorb or learn more of the environment than was previously possible. In general terms one could say that this theory does not show how it would avoid monotony and seems to be contrary to the principles advocated by other writers such as peter f smith, Robert venture, who argues that meaning, learning and intensity of perception are a direct function of the complexity of the environment.

2.3.4. Bentley -Responsive Environment

Bentley l. et al. (1985) formulated a set of guidelines to make the built environment should provide its user with essentially democratic setting, enriching their opportunity by maximizing the degree of choice available to them, we call such place responsive. These guidelines include the following: Permeability, Variety, Robustness, and Visual appropriateness, Richness, Personalization and Legibility. Permeability is a property of how easy it is to move through an environment and depends heavily upon the paths and objects placed within the space. There are two types of permeability: physical properties (e.g. a path) and visual appearance. Urban designer must always consider permeability first because it involves pedestrian and vehicle circulation within the city district as a whole. The greater the number of alternative routes through an environment, the greater people's freedom of movement and, therefore, the greater the responsiveness of that place. Variety refers to the range of activities, people and building forms which can be found in a space. The varied nature of people, forms and activities will create a range of meanings and in turn the meanings may influence the variety of options available. In

order to maximize the variety of uses a designer should have to demonstrate level of demands for various uses and, then, determining the widest mix of uses feasible economically and functionally. Legibility is how easy it is for a person to construct a mental map of their environment and depends to a large extent to the form of the environment and the activities people undertake. Lynch (Lynch, 1970) discusses many features such as paths, nodes, landmarks, districts and edges. It relates to the ease with which people can understand the spatial layout of a place. An urban designer can determine and enhance the perceptual clarity of the paths, landmarks, edge, node and district through consideration of permeability and variety.

Node is focal places such as junctions of path extend from roundabout to market square. Node is key physical element which has role in shared image/ legibility. Legibility of node can be increased through distinctive corner building, splayed corner help at crossroad between they focus building on center of space; give sense of enclosure because they form concave shape; height/ width ratio not greater than 1:3, offset junction increase sense of enclosure but small if there‘s building closing view it reduce visual permeability; splayed corner and set back help deflect eye toward next path and increase concavity of space. Eg. Arras, France, Bath England, Aix-en- province France**.** Where nodes are large, there are more possible entrance positions. If wall defining entrance path continue uninterrupted to form wall of node the node itself may read as a mere widening of path, with the entrance located away from the corner the node seem distinct from path leading into it. It strengthens if it‘s impossible to set straight through from entrance to exit. But increase in spatial definition must be weighed against possible loss of visual permeability. Larger node usually has high ratio of enclosing wall to street opening on plan but more difficult to enclose in section. Greater plan enclosure, height/ width ratio can be opened up to 1;4 before enclosure seem to weak. Effective width can be reduced by tree or wall or height can be increased by roof pitches, balustrades or change in ground level.

2.3.5. Conclusion

Finally, to conclude with the previous theoretical approaches, lynch and Bentley has a supportive theory that shows the importance of node for imageability and legibility of city as well as for the development of human centered environment but Steinitz explain node don‘t have any role in image of city. But in my opinion node is important element of city which shape city as well as has capacity to evoke human if it‘s properly designed in a way that satisfied human need.

2.4. Human centered Vs. Car dominated

2.4.1. Introduction

This section of the literature review critically examines human centered and car dominated environment to understand their meaning, need and character. The different measurements used for evaluating if the existing environment is human centered or not.

2.4.2. Human centered

The built environment should provide its user with essentially democratic setting, enriching their opportunity by maximizing the degree of choice available to them; we call such place responsive or human centered environment (Bentley l. et al. (1985)).

2.4.2.1. Human-centered design

. Human-Centered Design is the discipline of generating solutions to problems and opportunities through the act of making ―something" new, where the activity is driven by the needs, desires, and context of the people for whom we design. Solutions include products, services, environments, organizations, and modes of interaction. The reason this process is called ―human-centered" is because it starts with the people we are designing for **(**IDEO, Human centered design).

2.4.2.2. Human activity

Human activity is what people do, pretty much have always done, and will probably keep on doing. Typical activities are listed first with locations and kinds of places in parentheses (Dobbins, 2009).

1. Living, sleeping, eating, procreating (home, housing—residences)
2. Working, making a living, producing (office, factory, outdoors— workplaces)
3. Shopping, trading, exchanging (shop, mall, market, marketplace— commerce)
4. Learning and meeting other functional needs (school, health center, service centers generally—institutions)
5. Relaxing, playing, entertaining (leisure, culture, sports, time off— recreation)
6. Driving, riding, walking, biking, moving about, communicating (travel ways, communication channels—infrastructure)

2.4.2.3. Basic human needs

Urban design should be about designing for human needs. Hildebrand (1999) defined human need is one of sustainable design principles which are important to enhance Imageability. As successful places support and facilitate the activities of people, the design of urban spaces should be informed by an awareness of how people use them.

Basic human needs human motivation by Maslow (1968), who identified a five-stage hierarchy of basic human needs which include physiological needs, safety and security needs, affiliation needs, esteem needs, and self-actualization needs. Those needs respectively related to warmth and comfort, to feel safe from harm, to belong to a community, in order to feel valued by others; and for artistic expression and fulfillment.

According to Transport for London (2005) 7Cs are most important measurements of pedestrians or people environment used to classify and prioritize their needs. The seven ―7Cs" as the following:

Connected: The extent to which the pedestrian network links to key trip origins and destinations, as well as the extent of linkages between different routes on the network.

Convivial: The extent to which walking is a pleasant activity, in terms of interaction with people, the built and natural environment, and other road users.

Conspicuous: The extent to which walking routes and public spaces feel safe and inviting for pedestrians, in terms of clear and legible signing and information.

Comfortable: The extent to which walking is accommodated to competences and abilities of all types of pedestrians;

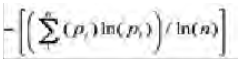
Convenient: The extent to which walking is possible and able to compete with other modes of transport in terms of efficiency (time, money and space).

Coexistence: The extent to which the pedestrian and other transport modes can exist at the same time and place with order and peace.

Commitment*:* The extent to which there exists engagement, liability and responsibility towards the pedestrian environment.

2.4.2.3.1. Measurements of pedestrian environment from the 7Cs perspective

Basic needs of human/ pedestrian (7C's)	Measurements	variables and standard
Connected	Sidewalk continuity; number of crosswalks per intersection (Maghelal 2010)	Sidewalk length and length of traffic lane; number of crosswalks
	Number of intersection; link to node ratio; and pedestrian route directness (Steiner et al,2004)	number of intersection per area; number of segment and number of intersection; network distance & actual/straight distance high no. of intersection with less cul-de-sac has high connectivity; link to node ratio has value between 1.4-1.8;

		PRD has value 1.2-1.7
	Block length (Handy et al., 2003)	length of block maximum length of block 91-183 m
	Gateway (Soltani & Allan ,2005)	public transport within 200m and 400m buffer 400m walking is convenient distance to reach a transit station
	perception of pedestrian on sidewalk LOS and continuity (Park, 2008)	over crowdedness of sidewalk and cars entering driveways
Conspicuous	Enclosure; pedestrian sign coverage as well as perception of pedestrian on scale and enclosure, visual attractiveness and visual variety(Park, 2008)	Street width, building height, set back ; number of pedestrian crossing with signal; landscaping and also the streetscape; presence of interesting thing to see 3 story (9m) building with 11m building width maximum is the human scale.; height to street width is best if its 1:3.3 and 1:2 ratio has strong sense of enclosure (Jacob,1967); setback don‘t has to be >70 feet if it is more than that it will be taken as vacant lot
Convenience	land use mix (Frank ,2005)	proportion of sq. m of land use and number of land use  Pi = proportion of sq. ft of land use; n = number of land use It has value range from 0 to 1. If the LUM has 0 values it shows there is only one kind of land use but if it has value of 1 then that area will have balanced mix of all uses.
	Existence and quality of facilities for the blind and disabled; maintenance and cleanliness of walking path; and permanent and temporary obstacles on walking paths and Amenities (benches, public toilets) (Krambeck 2006)	presecence of disability infrastructure; presecence of open sewer and waste disposal place; presence of obstruction; and pedistrian way finding sign
	Perception of pedestrian on easy access to local store;	availability of stores and other service; waiting time at crossing and feel about crossing

	and easiness of pedestrian crossing(Park, 2008)	
Comfort	buffer width (Maghelal 2010)	width of shoulder lane and landscape strip
	location of sidewalk (Landis 2001)	distance of sidewalk from edge of road
	Surface quality (Gallin 2001)	type of pavement material, level of maintenance
	Average number of upper level windows per 500ft sidewalk, sense of safety and perception of pedestrians Buffering negative environmental effect (Park 2008)	number of window facing to roundabout; exposure to direct sunlight, noise, fume and vibration from street traffic
	Boarded up buildings and unused plots (Evans 2009)	blind fences and vacant/abundant spaces
	Buffer width, lighting and Personal security (Maghelal 2010)	width of shoulder lane and landscape strip; number of pedestrian scale streetlight; number of burglary assaults and theft
Conviviality	pedestrian flow rate (Gallin 2001)	pedestrian flow within 15m at pick hour
Coexistence	safety, traffic volume and speed (Maghelal, 2010)	Number of accidents/ intersection; average daily traffic; average speed on road
	Crossing safety (Krambeck, 2006)	
	Traffic calming elements, traffic lanes (Park 2008)	Number of traffic calming element; number of traffic lane
Commitment	Existence/enforcement of pedestrian safety laws/regulations as well as funding and resources devoted to pedestrian planning (Krambeck, 2006)	safety rules and laws; amount of money funded for pedestrian facility

Table 2. Parameters used to measure pedestrian environment (source: book review)

2.4.2.4. Factor for loss of human centered spaces

Modern environment eliminate range of choice and meaning attached to traditional cities and becomes a standard whose character is gone for function and profit. It response to the

human needs just by sheltering them. It neglect of urban quality is due to the unprecedented pressures for change of the present day. As visual image of urban environment becomes without meanings, as well as without visual qualities, there lies the problem. Modern urban environment is monotonous and ugly which is a result of loss of urban values and neglecting visual quality. This led to simplified buildings and layouts that cater efficient vehicle movement. A design considering visual quality of the environment can evoke satisfactory human response. Urban environment must be efficient in organization, servicing and ought to be a reasoning place where people can feel they belong and where the recognize not only other people as being familiar but building and spaces as well (Mokhtar, 2007).

Lost spaces are undesirable urban areas that are in need of redesign- anti space, making no positive contribution to the surrounding or users. They are ill defined, without measurable boundaries and fail to connect elements in a coherent way. There are five major factors that have contributed to lost space in our cities. It includes; an increased dependence on automobile, attitude of architect of modern movement toward open space, zoning and land use policies of the urban renewal period, privatization of public space and change in land use (Trancik, 1986).

The Automobile – large space given for road and parking because buildings are separated, encompassed by vast open areas without social purpose. Streets no longer essential urban space for pedestrian use, function as fastest automobile link. Square is a parking lot framed by unrelated building.

Modern Movement in Design - It ignores or denied the importance of street space, urban square and garden and other important outdoor rooms and only concerned with total composition and organization. Modern space is in effect, anti- space; the traditional architecture of streets, square and rooms created by differentiated figure of volumetric void is by definition obliterated by presence of anti-space led to erosion and eventual loss of space and results of this can be seen all around us. Designers and builders influenced by the modern movement abandoned principles of urbanism and human dimension of outdoor space established in the urban design of cities of the past. With the advent of mechanical elevator and new technologies of construction, modern city has become an environment of high rise towers removed from street life. Social and commercial role of traditional street has been further undermined by modern design such as enclosed mall, midblock arcades and sunken or raised plazas. The intension is not to imply that architecture and urban design of the last half-century has been one of failed. Functionalism laid to loss of traditionalism space. Modern

architecture and urban design often criticized as inhuman and repressive, despite the high social and political ideals shared by influential designer over last hundred years. They fail to realize manmade environment is political system in its own right; try walking through wall and you'll notice that it is physical fabric as well as the way it is managed, that sets constraint on what you can do and can't do (Bentley l. et al. (1985)). "Legislation too often leads to excessive emphasis on those aspects of design which are quantitative rather than qualitative.

Industrialization - Modern industrial periods also one of the reasons for weakening civic usage possibilities of the public spaces and the disappearance of political representation, the conversion of public squares to traffic nodes or transition areas (Bilgin and Boysan 1996), the state of turning users of public spaces to the passive viewers (Sennett 1992), and "speed' that changes our spatial understanding (Virilio 1994). One of the critiques that Carmona (2010) discusses relates to the phenomenon of "Invaded Space", resulting from the loss or lack of social function and experiences in urban spaces that is now over used by traffic and private cars.

Zoning and urban renewal **-** Urban renewal project rarely corresponded in spatial structure to the evolved community pattern they replace, nor did they respond to social relationship that give meaning to community existence. Zoning legislation had the effect of separating function that had often been integrated. They fail to recognize the importance of spatial order to social function. Zoning subdivide cities into homogenous district separated by arteries, area between districts are usually major lost space in the urban fabric. It is also ironic to consider that many urban buildings "listed for their architectural and historic and the majority of urban conservation areas designated in respect of their outstanding character (and general popular residences) , could not be reconstructed today.

Privatization of public space **-** The sanctity of private enterprise has also contributed significantly to lost space in our urban center. Economic health of a city strengthen its downtown, it also create heavy demand for floor space in the center, thereby pushing toward the vertical city. A byproduct has been the appropriation of public space for private expression. The city becomes showplace for private ego at expense of public realm.

Changing land use **-** The relocation of industry, obsolete transportation facility, abandoned military properties and vacated commercial or residential building have created vast area of wasted or underused space within the down town core of many cities. Because of

unconditionally adopting planning standards and building regulations land use zoning has created expansive areas of homogeneous activity.

2.4.3. Cities for Cars, Not for People

One of the most critical challenges facing cities worldwide is automobile-dependent urban development. With economic growth and modernization, many cities in developing countries have begun to follow the trajectory of motorization that developed countries once followed but at a much faster rate. Worldwide, rising incomes are fueling automobile ownership, spurred by increasingly affordable vehicles. Many urban inhabitants often the middle-income populations are shifting from public or non-motorized transportation to private automobiles. In addition, higher incomes allow people to afford more spacious houses on large suburban lots, using their own cars to reach jobs and educational opportunities in the city (Suzuki, Cervero, Iuchi, 2013).

Automobile-oriented built form marked by spread-out development, noncontiguous land uses, large city blocks that are unfriendly for pedestrians, and strip development is an inevitable consequence of an automobile dependent lifestyle. Such kinds of development will led to different problems which includes deteriorating traffic conditions and congestion, excessive energy consumption and pollution, traffic accidents rises, health problem, destabilize climates, leading to rising sea levels, flooding, extreme heat waves, and droughts, provide limited choices on where to live, often forcing people who cannot afford a car to live in informal settlements on the urban fringe as a consequence, they often have limited access to basic urban services, jobs, and educational opportunities, even where transit services are available, the cost is often substantial, majority of public investment goes to automobile-related facilities, such as roads and parking, taking money away from the upgrading of public transit or non-motorized transport facilities, such as footpaths, bike lanes, and bike parking and it also cause time pollution(Suzuki, Cervero, Iuchi, 2013).

2.4.4. Conclusion

Human centered environment is an environment developed from human perspective and provides public space which satisfies the diversified need of human to carry out his/her activities. An environment which satisfies human need has important role in the imagiability of city. But in the present day human based environments are lost because of different factor including automobile, modern movement in design, industrialization, zoning and urban

renewal, privatization of public space and change in land use. This led to lose of image of the city.

2.5.Different practices of node development in different countries

2.5.1. Introduction

This section of the literature review different countries experience on node development specifically on roundabout type of junctions. It tries to show case areas having shared space design approach developed based on mutual agreement among motorists, cyclists and pedestrians concerning the widest possible elimination of traffic controls, light signals and signing. These design approach intended to create a voluntary change of relationship among all the users of public space, a change in social behavior that is to be supported by appropriate traffic planning.

Drachten – Laweiplein roundabout (Hamilton-Baillie, B. 2005)

Drachten – Laweiplein roundabout is an inner-city intersection in the Municipality of Drachten (approx. 30,000 residents) in Friesland (the Netherlands) with a traffic volume of approx. 20,000 motor vehicles per 24 hours. The dismal surroundings of this busy junction, and the wide approach roads were congested, dangerous, and did little to foster civic activity. Pedestrian and bicycle routes were inconvenient and unattractive. It was converted from a signal-controlled intersection into a showcase shared-space project involving a roundabout.

Figure 8. Drachten – Laweiplein roundabout before and after (Source: Hamilton-Baillie, 2005)

The urban quality of the central intersection, on which the Municipality of Drachten Theatre is located, was allegedly upgraded, pedestrians and cyclists being given priority over private motor vehicles. In this regard, approximately 5,000cyclists ride through the intersection daily. The design deviates from the usual characteristics of small roundabouts. For instance, signposting and marking for non-motorized traffic are notable by their

absence; the pavement and newly created open-space areas are used by all non-motorized traffic participants without any channelization. It had all of the elements of shared space with the exception of parking for obvious reasons. It has flush kerbs, a ramped entry, no splitter islands and a bicycle lane around the outside. It is the most pedestrian friendly roundabout. It special because: a ramped entry prior to the pedestrian crossing this slow cars into the crossing and intersection, there are no splitter islands at the entry exit of the roundabout which swing vehicles wide out of the roundabout as they were exiting and well anticipated by entering drivers and appeared to be a factor in controlling the entry speeds, constructed higher than the abutting footpaths, has flush kerbing which technically allows vehicles to seeing wide, and has large pedestrian crossing but without flashing lights.

Crossing zones for cyclists are located directly at the entrances to the circle; pedestrian crossings are placed approx. 30 m away from the roundabout lane on all four approaches. In doing so, a conscious decision was made to mark linear pedestrian crossings at positions on all the entrance legs. Cars always stopped to give way to pedestrians on the crossing. The cyclists seemed to judge their speed and trajectory to pass over roads without delay. The roundabout is almost unsigned; "Roundabout" traffic signs are placed in the middle of the circle. Cyclists have the option of blending with the mixed traffic in the circle lane or riding through the intersection on the pavement or open-space areas. Accordingly, there are no direction or route indicators on the pavement; cyclists can ride through the intersection without any restriction. The intersection has an attractive design with fountains and places to sit and linger. The roundabout was observed to operate very smoothly and without significant delays.

As an architectural feature to improve the quality of the space there are fountains which react to the traffic volume. The reconstructed square includes a compact roundabout that forms an integral part of a coherent area of public space. Vertical water jets unite the space; their height responding to the volume of traffic. Despite the volumes of traffic, the informal protocols that have emerged spontaneously among drivers, cyclists and pedestrians allow free-flowing movement and a lively, animated public realm to emerge. The fountains attract human activity, especially children‘s play, close to cars, buses and trucks maneuvering around the central island. The proximity helps to slow traffic, which in turn improves the traffic flows. After a few years of operation the new arrangement has succeeded in creating a space that encourages public life.

Figure 11. Laweiplein, Drachten- flush kerb (Source: Hamilton-Baillie, 2005)

Figure 10. Laweiplein, Drachten- fountain, pedestrian crossing, lighting and ramped entry (Source: Hamilton-Baillie, 2005)

Figure 13. Laweiplein - flash kerb (Source: Hamilton-Baillie, 2005)

Figure 12. Laweiplein - no splitter island (Source: Hamilton-Baillie, 2005)

Figure 15. Laweiplein, bus swinging wide (Source: Hamilton-Baillie, 2005)

Figure 14. Laweiplein - car exiting (Source: Hamilton-Baillie, 2005)

Figure 16. Laweiplein-roundabout entry ramp (Source: Hamilton-Baillie, 2005)

Figure 16. Laweiplein roundabout attractive features (source;

Chapter 3. Research Methodology

These section will introduced the method employed in this research, the criteria used for the selection of the case study area, type of data and collection techniques, sampling method and methods of data analysis.

3.1. Selected Research method

In this research case study method is used because of the presence of many roundabout in Addis Ababa, it is very difficult to make an in depth analysis on all roundabouts. According to Yin's (2003: 13–14), –A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between object of study and context are not clearly evident. It relies on multiple sources of evidence". So this methodology is appropriate to investigate the recently happening problems in our daily life with support of large evidences, it makes it fit with case of study.

3.2. Research Approach

The research approach has employed both qualitative and quantitative approach which is called triangulation. Qualitative research approach related to quality or kind including attitudes, behavior and experiences. Quantitative research is based on the measurement of quantity or amount that generates statistics. In the case of this research, the study uses the two approaches, simultaneously because of the availability of data. Thus, in this study both qualitative and quantitative known as triangulations were implemented by the study to strengthen the research in different perspectives (Dawson, c., 2007).

3.3. Data Type

Both primary and secondary data types were the main source of information for this research. The primary data come from your own observations or experience, or from the information gathered personally from other people. Secondary data's are those collected from published and unpublished documented data made by different researchers and sectors.

3.3.1. Primary Data type

In this research primary data's collected to achieve accurate, reliable and representative information for the study. It includes number of people and car coming to Diaspora roundabout; size of Diaspora roundabout; existing land use found around Diaspora roundabout; height of building and width of setback found around roundabout; number of windows facing towards the roundabout; size, material, maintenance and presence of pedestrian facilities (crossings, sidewalks, bench, signs, street light, shade and buffer, disability infrastructure); length of block; speed of vehicle; number of intersection and

segment connected to the roundabout; network and actual distance of roundabout; public transport found within 200 and 400m; perception of pedestrian on roundabout; and number of traffic calming element .

3.3.2. Secondary Data type

In this research primary data‘s collected including number of accidents and crime occur on the roundabout; safety rules and laws; amount of money funded for pedestrian facility; Addis Ababa standard of roundabout design; Nortek and structural map of Addis Ababa as well as the roundabout.

3.4. Data source and collection method

Both primary and secondary data types were the main source of information for this research obtained through questionnaire, observation, site survey/ measurement, photograph to attain comprehensive understanding of problems occur on study area.

3.4.1. Primary data source and collection method

The primary data were collected from site survey and questioners responded by sample pedestrians coming to roundabout. The primary data directly collected by using structures questionnaires adopted from Park, S. (2008), and edited to fit for roundabout, direct observation, application of different measurement including meter and radar. Questionaries‘ help to understand the perception of pedestrian on the roundabout from different perspective. All the methods used to collected data, identify the problems and generate finding.

3.4.2. Secondary Data Sources and collection method

The secondary data were collected from magazines, journals, reports, official documents, plans published and un-published sources from different institution including AACRA, A.A city administration planning office, Yeka and Bole sub city police station and Addis Ababa transport authority also carried out in this study.

3.5. Sampling techniques

The major purpose of the research is to assess problems occur in car dominated Diaspora roundabout and perception of pedestrian on the roundabout. To undertake this study appropriate technique used to improve accuracy of research findings. In order to do that simple random sampling from probability sampling were used.

3.6. Data Analysis and Interpretation

The primary and secondary data collected, interpreted and organized into their representative categories so as to come up with logical results. In dealing with the qualitative analysis based on the evidence collected from the different sources made to be carefully understandable and interpreted in order to use it together with the quantitative data. In general the data collected will be analyzed using different parameters developed by researchers from perspective of basic need of pedestrian. Then those parameters applied by integrating with computer software‘s; GIS, excel and CAD. Those software‘s are the easiest and quickest way to analyze the data. Then the analysis represented through maps, tables, graph and text.

3.7. Conclusion

According to descriptive study, simple random samplings from probability sampling were used, and primary and secondary data sources were used in this research. The data collection tools were; questionnaire, field observation and document analysis. Those data‘s analyzed by different software‘s including GIS, excel and CAD and interpreted using tables, charts and figures.

Chapter 3. Contextual background

3.1. Traditional roundabouts of Addis Ababa

In the earlier period different squares or junctions were developed including Menelik II square, Haile Selassie I star square, Miazia 27 square, Yekatit 12 square, Yekatit 23 Adwa square, Independent square and Parliament square developed in imperial administration period (A.A. municipality).

Menelik II square- placed facing St. George‘s cathedral. It‘s meeting point of Eden, Mesfin Harrar, Abuna Petros and John Melly streets. The equestrian statue of Emperor Menelik II in the center of square was erected in November 1930. The square with neatly laid stone pavement all around and it‘s also a favorite spot where public gather to listen to radio broadcast. It is surrounded by different function like Municipality council and town hall, Fire brigade, water distributing center, St. George church and open market.

Haile Selassie I star square- it‘s a meeting place of Haile Selasie I avenue, Patriot street, Cunningham street, Eden street and Churchill road in the heart of city. It‘s now converted into neat little garden, in the center of which are two loud speakers with adequate sitting accommodation, the spot become a popular evening resort. The gathering of people here is particularly sizable on national holiday. It was named after present emperor in 1930, the yr of his coronation. . It is surrounded by different function like Menelik II School, National pharmacy, florist and flower vendor, green groceries, cinema Ethiopia, and George Talanos photo studio.

Miazia 27 square- it‘s a junction of Haile Selassie I avenue, Empress Menen street, King George VI street and Queen Elizabeth street. In the center of square, unveiled in 1944 stand a monument in memory of Ethiopian patriot the valiant member of underground movement during the 5yr Italian occupation who fought by side of Ethiopian allies for liberation. A figure of Imperial majesty and name of patriot and refugees are all carved on this monument. The place provided with a radio loud speaker, attract large number of listener in the evening.

Yekatit 12 square-situated infront of Haile Selassie I hospital at junction of king George VI street, crown prince Asfaw Wossen street, Emperor Theodros street, Emperor Yohannes street, Russia street and Weatherall street. In the center of square stands a monument in memory of Ethiopia Martyrs who were massacred by Italians in February 1937, upon Marshal Graziani‘s order. It is surrounded by different function like Haile Selasie I hospital, Quedamai Bette Medhanit Ethiopia, Menbere Leoul Markos church and public park.

Yekatit 23 Adwa square- situated in front of ministry of justice building, at junction of Churchill road, Empress Taitu Street and Field Marshal Smuts Street. In the center there is a little garden, shaped like Haile Selassie I star. It is surrounded by different function like Ministry of war, ministry of justice, green groceries, Public Park, and pharmacy.

Independent square-it's a meeting place of Churchill road, Beyene Abasebsib Street, opposite the railway station. The imposing statue of the lion of Judah' was removed by Italian upon entry into capital in its place small garden can be seen today.

Parliament square- found between the old palace and parliament. It's associated with memorable speech by Emperor in 1936, when enemy has penetrated into Ethiopia and national mobilization was called for speaking from the spot, his majesty said emperor is speaking to you today, will never abounded you and is determined to shed his blood for freedom of Ethiopia. It is surrounded by different function like Ethiopian parliament.

All the above junctions were place different path meet which has their own identity and historical meaning attached to it. Their name as well as the monuments/landmarks placed inside those junctions shows the time and the event happened at that period as well as government system. Most of them developed to memorize those patriots fought and died to keep the city from foreign attackers. Those junctions also used as social places where people gather for hearing information and celebration of holidays as well as for political purpose. They are also a place of high level order services provided like hospital, schools, governmental offices, market places, park & garden, religious centers and cinema.

3.2. Current development of roundabouts of Addis Ababa

In present day the planning and design of Addis Ababa road network including intersections/ roundabouts made by Addis Ababa city road authority (AACRA, 2003) which was established by the Addis Ababa city government in 1998. According the regulation No7/1998 AACRA is responsible in plan, construct and maintain the city road network based on manual in manner that; improves the livability of the Addis Ababa community, affords safe travel conditions for all road users, support socio-economic development in a cost effective way, reduces transport costs for industry, promotes environmentally sustainable solutions, support the city master plan, make effective use of public fund, provide roads fit for their purpose and preserve the existing transport infrastructure by appropriate and timely maintenance. It ensure all projects built in considerations of local circumstances including

local community, natural environment, cultural heritage, city government‘s strategic plan and investment strategies as well as city government master plan.

The A.A. master plan revision project was launched in 1999 shows the future direction of the planning and design of the transport infrastructure for Addis Ababa, city government‘s focus will be on how roads and road transport will be positioned to meet the emerging requirements of business, the community and government. But to meet there needs, city government is challenged with increasing traffic and environmental demands on the road network, coupled with the need to manage an extensive and diverse aging network using limited road funds derived from city government, different incomes which the authority collects for the service it renders and the community. To meet the need _whole of network‘ approach to planning and investment is needed to meet city government and community needs. So in order to move effectively from the long term road network strategy to specific projects generated for a road program in line with the available income, several phases in the planning process occur (see fig. 17).

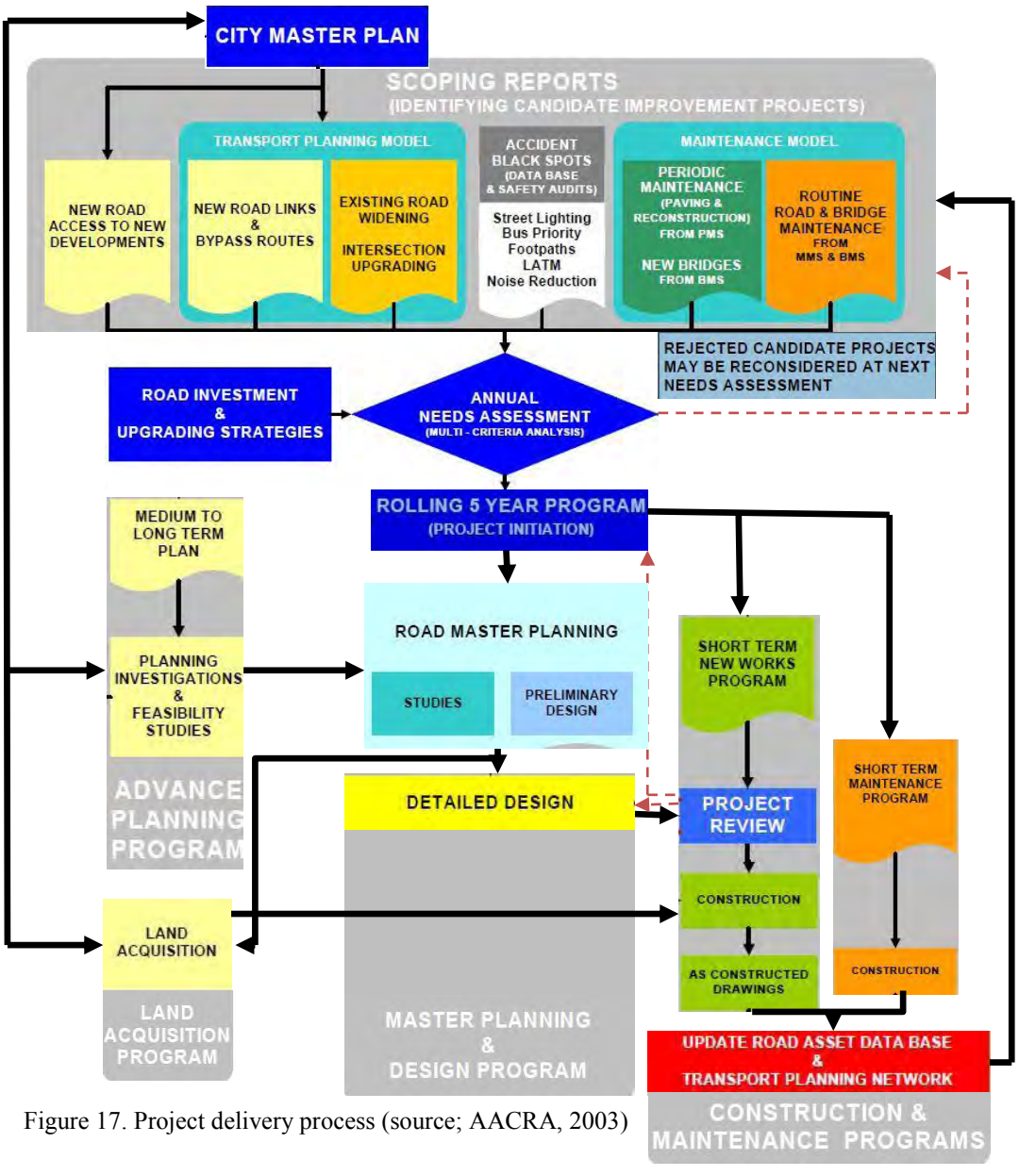


Figure 17. Project delivery process (source; AACRA, 2003)

A long range planning reserve land for the future new roads and give consideration to reducing road user cost and accidents, improving flood immunity, improving the reliability of roads by minimizing delays from congestion, having consistency in condition and standards, integrate transport and land use needs and the relative interaction between them, and preserving the existing transport infrastructure assets by timely maintenance. It include treatments like realignment, town bypasses, bridge strengthening, intersection upgrading, safety treatment, integration of road improvement projects with other modes of the development, provision of bus lane / bus priority measure and footpaths.

3.3. Roundabout design guideline in case of Addis Ababa (AACRA, 2003)

Roundabout should be best if they are located at intersection of arterials, freeway terminals and freeway interchange having four leg and 90 degree angle between them in order to help motorist to determine appropriate lane choice and reduce confusion. It performs better at intersection with roughly similar traffic flow and high proportion of right turning traffic.

The maximum number of legs allowed for roundabout is four if it is more it led to driver confusion in determining appropriate lane choice.

For driver intend to leave multi roundabout less than and more than half way around it and if an official traffic sign indicates a different course the driver must use right lane, left lane and follow the course indicated respectively.

Line marking system for multi-lane roundabout places pavement arrow on the approach legs to direct motorist to correct lane choice for the particular exit they require.

For roundabout to perform effectively they must be easily identified in road system, layout must be apparent to approaching driver and the approaches must encourage drivers to enter the intersection slowly. Adequate sight distance should be provided to enable driver to observe the movements of other vehicles, cyclist and pedestrians.

It should has to be a maximum of two circulating lane but greater than or equal to maximum number of entry lane and lesser exit lane to reduce rate of accident. The number of exit lane must not be greater than the number of circulating lanes.

Roundabout with larger diameter enable for better geometry design and to reduce angle formed between entering and circulating vehicle path which slower the speed of vehicles which in turn lower accident rate. It also provides greater separation between adjacent conflict areas and makes it easier for entering driver to determine movement of vehicle at different position.

Speed Environment	Central Island Diameter	Circulating Width
60	20	7.1
70	20	6.7
80	25	6.5
90	25	6.5
100	25	6.5

Table 3. Minimum central island diameter for single lane roundabout (source; AACRA, 2004)

Speed Environment	Central Island Diameter	Circulating Width
60	25	10.3
70	30	10.0
80	40	9.6
90	40	9.6
100	40	9.6

Table 4. Minimum central island diameter for double lane roundabout (source; AACRA, 2004)

The roundabout Width of circulating carriageway depends on the number of circulating lane and radius of vehicle path within roundabout. Single lane should cater for movement of largest vehicle and need 0.6m offset from each edge of vehicle path to lane edge/ kerb. Dual lane need cater for movement of largest anticipated vehicle alongside passenger car and need 1.2m from both edge vehicle path and 0.6m from edge of vehicle path to lane edge/kerb.

Small width of entry and exit lane provides small vehicle path radii on entry curve and more deflection through roundabout which reduces speed. Lane with 3.4- 4m and 5m for kerbed single lane entrance and exit which allow traffic to pass disabled vehicle.

Appropriate radius on entry curve encourage driver to slow down before reaching roundabout. If it‘s too large it will allow high speed entry. If there is adequate deflection of path of vehicle of entering important for safe operation and can be achieved by**;** alignment of approach carriageway and shape, size and position of approach splitter island**;** provision of suitable size and position of central island and Staggered or non-parallel alignment between entry and exit.

Central Island is preferable if it has a circular shape except site condition doesn‘t suit. Roundabout with raised Central Island give good driver recognition of Central Island. For roundabout 20-25m central island diameter should has to be raised not more than 0.2 m due to visibility constraint. Vegetation needs to be outside sight triangle unless low growth vegetation, Contrast with vegetation outside roundabout to help increase driver recognition of it but trees/planter box not be placed within clear zone from circulating carriageway and also prevent excess water of spray flowing onto circulating carriageway because it increase chance of single vehicle accidents rather use only drip irrigation system is appropriate. It should be kerbed painted white to enhance prominence of roundabout.

Kerbed Splitter Island should be provided on all approaches. It provide shelter for pedestrian, assist controlling entry speed, guide traffic onto roundabout and deter left turner from taking dangerous wrong way shortcut movement. It must be light colored/ white painted. It direct vehicle on smooth curve and at an angle which afford driver comfortable sighting of approaching traffic. Right hand edge of entry curve should tangential to Central Island. At the arterial it must be 2.4m wide to pedestrian and visible area minimum 8-10$m^{2.}$ For high speed area -60m which gives warning and slow down? Extend where driver expected to reduce speed.

In respect to Sight distance there are three criteria for vertical and horizontal geometry which includes alignment which create good view of splitter and Central Island and circulating carriageway to driver; driver have clear line of sight (eye h=0.05m) to traffic on (h=0.6m). Minimum length of line of sight based on distance travel in 4sec at 85^{th} to speed + stopping distance, absolute minimum distance in 2sec+stopping distance and distance calculate from conflict point along vehicle path from previous approach leg and Adequate sight distance to see other vehicle allow driver (eye h=1.05m) time to stop and avoid a vehicle driving through roundabout.

Speed	40	50	60	70	80	90	100
Stopping distance	39	54	71	91	114	140	170

Table 5. Stopping distance with respect to speed (source AACRA, 2003)

A maximum crossfall of 0.025 to 0.03 m/m should be adopted for the circulating carriageway. It‘s adequate to allow pavement drainage provide construction is tightly controlled and provide additional driver comfort. For roundabout in slower speed areas where the terrain is relatively flat, adverse cross fall is usually provided on the circulating carriageway. On circulating carriageways with varying crossfall, the crossfall should stay with the range of + or – 4%. If the slope of land is greater than 4% it will be necessary to bench the area for the roundabout, using a desirable maximum grade of 3% with absolute maximum grade of 4%.

It‘s desirable to have adequate amount of clear zone where there are no roadside hazard (light and power poles, large trees and sign support) on each side of carriageway. If roadside hazard can‘t be located outside the required clear zone, consideration should be given to making them frangible. If it isn‘t possible to remove roadside hazard or make them frangible,

protecting them with roadside barrier is necessary. However roadside barriers are a hazard in them and are the least desirable option. In addition roadside barriers in vicinity of the give way line often obscure visibility of circulating vehicles.

The pavement surface should be designed using high friction value materials (asphalt) and maintained in good condition to minimize single vehicle accident rate.

3.3.1. Roundabout design guideline for pedestrian in case of Addis Ababa

In planning and design of roundabouts special thought should be given to the movement of pedestrians. Roundabout is at least as safe for pedestrian because pedestrian are able to cross one direction of traffic at a time by staging on the splitter island. However pedestrian must cross with care because unlike traffic signals roundabout don‘t give positive priority to pedestrian over through traffic movement. Particular group of pedestrian such as elderly or children find traffic signals a more secure form of control for crossing a road.

Pedestrian delay at roundabout can be expected to be similar to other forms of non-signalized intersection control and generally less than at signalized alternatives.

It is important not to give pedestrian a false sense of security by painting pedestrian crossing lines across the entrance and exits of roundabout, but rather to encourage them to identify and accept gaps in traffic and to cross when it is safe to do so.

Consideration may be given to providing priority crossing e.g. zebra crossing, for pedestrian where; pedestrian volumes are high, high proportion of young, elderly or infirm citizen wanting to cross the road, pedestrians are experiencing difficulty in crossing and being delayed excessively.

If crossing at roundabout are chosen, they are best located 1 or 2 car length(6-12m) back from the holding line on the entry carriageway to enhance pedestrian safety and to enable driver to move into acceptable gaps in the circulating traffic unhindered by pedestrians. On the exit carriageway, the pedestrian crossing should be located 2-4 car length (12-24m) clear of the circulating carriageway to reduce the probability of vehicle, delayed at pedestrian crossing, queuing back into roundabout and blocking its operation. Again to minimize pedestrian accident at this location, the entry and exit speeds should be minimized by providing small radius entry and exit curves.

There are design considerations to enhance pedestrian safety at roundabout include: designing splitter island which are as large as the site allows, prohibiting parking on the

approach to the roundabout to provide clear visibility, provide street lighting which illuminate not only the circulatory carriageway but also the approaches, locating signs and vegetation so as not to obscure small and special crossing facilities. However where pedestrian volume are high serious consideration be given to the use of an alternative intersection treatment. This is especially true where the pedestrian content consists of school children or the elderly.

3.4. Conclusion

In earlier period most junctions developed at meeting of major streets having their own street name, function and meaning. Those junctions act as social space, information center and activity center were people meet, celebrate different traditional ceremonies as well as install monuments that has meaning to the society, gather information and access different function other than their use for movement. But in present day planning, construction and maintenance of roundabout and the road network of Addis Ababa is carried by AACRA considering society, economy, environment and city government‘s strategic plan and investment strategies as well as city government master plan according to the responsibility given by legal framework. But to meet the needs of different society, city government face problem because of increasing traffic and demands of new as well as management and maintenance of existing road network including roundabout using limited resource. So to meet the demand government adopted ‗whole of network‘ approach to planning and investment as well as provide road network including intersection in short, medium and long term program. In order to design AACRA use its own guideline for roundabout this gives more emphasis on space design of roundabout mainly from vehicle need perspective. It facilitates attraction of vehicle rather than pedestrian because it gives priority for vehicle and don‘t take into account the pedestrian needs as well as clear standard for pedestrians especially the disabled ones even though a few consideration to safety need of pedestrian is given by manual through providing crossing, Splitter Island, street light, signs, vegetation and providing clear visibility.

Chapter 4. Case area

4.1.Case study area

The study area is called Diaspora roundabout. This junction found in major sub center of Addis Ababa located at boundary of bole and Yeka sub city. Diaspora roundabout is a junction were four paths meet that led to Bole, Arat kilo, kotebe and Megenagna roundabout (see figure 2). It act as junction because it is a place were four paths meet and it is roundabout which is one type of junction, it act as transport node because of the presence of Megenagna terminal which is one of major transport node found in Addis were variety of transport choice and high flow of people perceived. There are also bus, taxi and LRT stations around it within a short distance. It acts as a center because it is one part of sub center delineated by master plan of Addis Ababa even though it doesn‘t provide what service a center provides. It is one the abandon and car dominated roundabout.

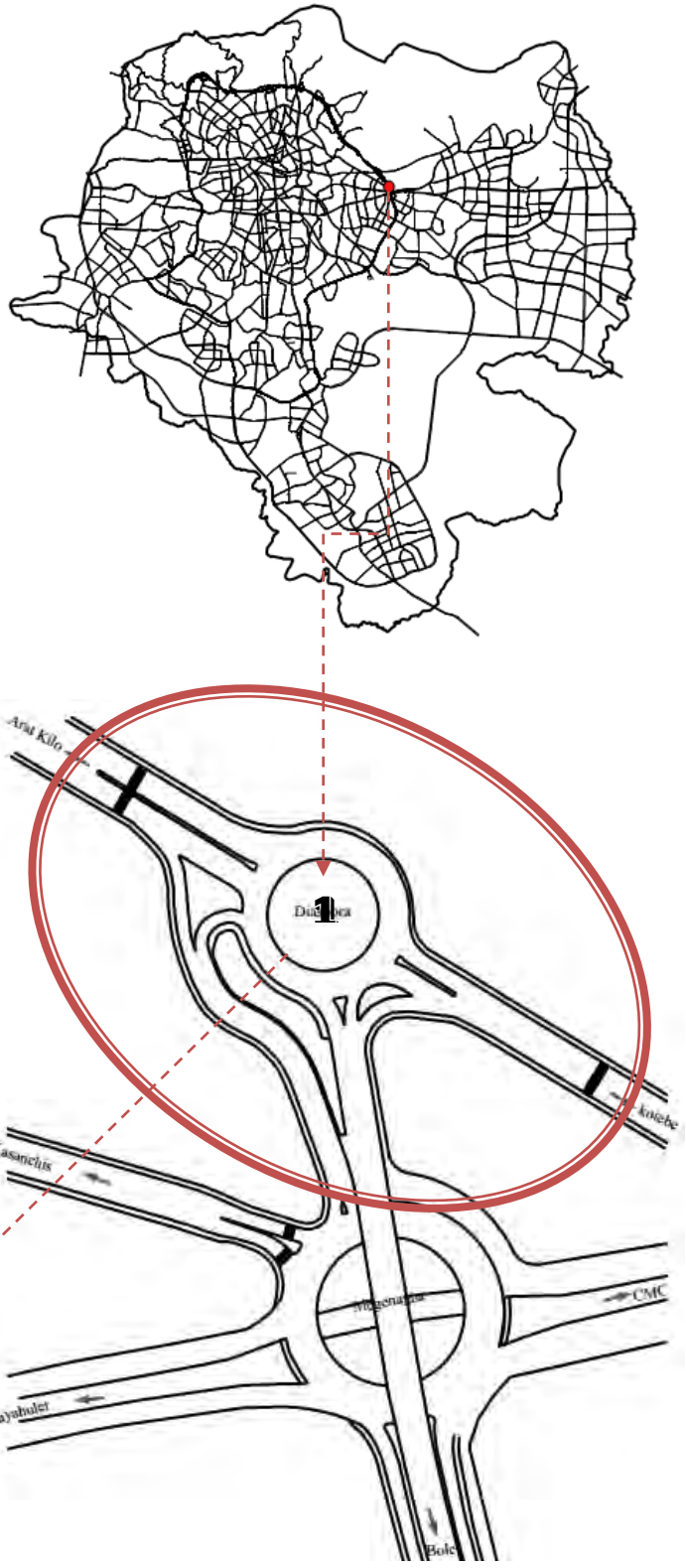


Figure 18. Location of diaspora roundabout (source; Addis Ababa structural road network map and edited by Senait Mohammed, 2006)

Figure 19. Diaspora round about (source; Senait Mohammed, 2006)

4.2. Data collected and Analysis

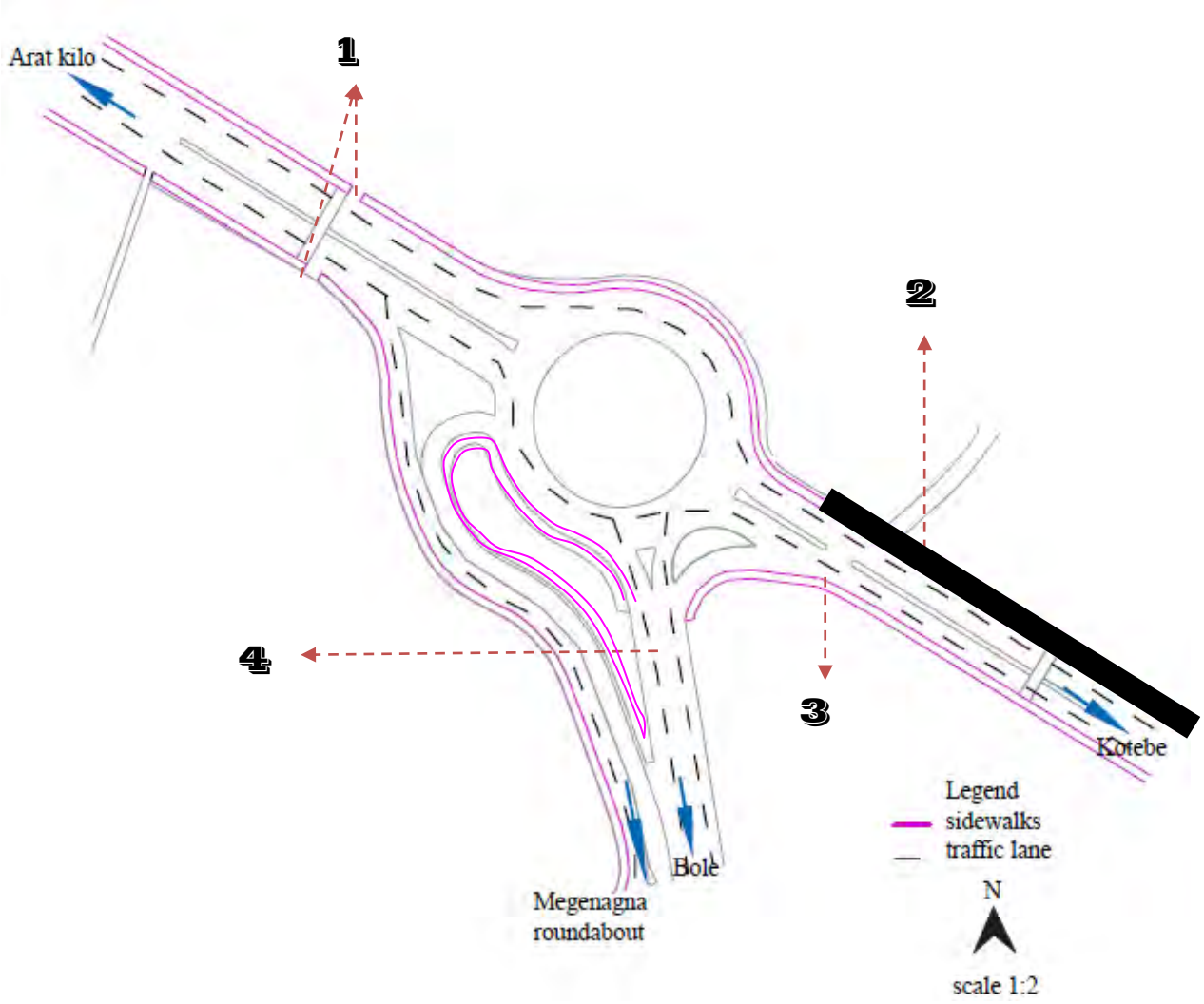
The analysis derived from site observations, perception of people interviewed during site visit, applications of different measurements developed by different scholars from pedestrian perspective. The analysis is done based on major 7 measurements of pedestrian environment which include connected, convivial, conspicuous, comfortable, convenient, Coexistence and Commitment.

1.2.1. Connectivity

Connectivity of pedestrian environment can be evaluated by application of different measurement on sidewalk, intersection, crossing, urban pattern and gateway.

1.2.1.1. Sidewalk continuity

According to Maghelal (2010), ***sidewalk continuity*** is one of measurement connectivity of sidewalk. It is a proportion of sidewalk length and length of traffic lane.



1 Driveway curb cut

2 Privatization of sidewalk for access and presence disposed construction material and open utility

2 not well managed drainage

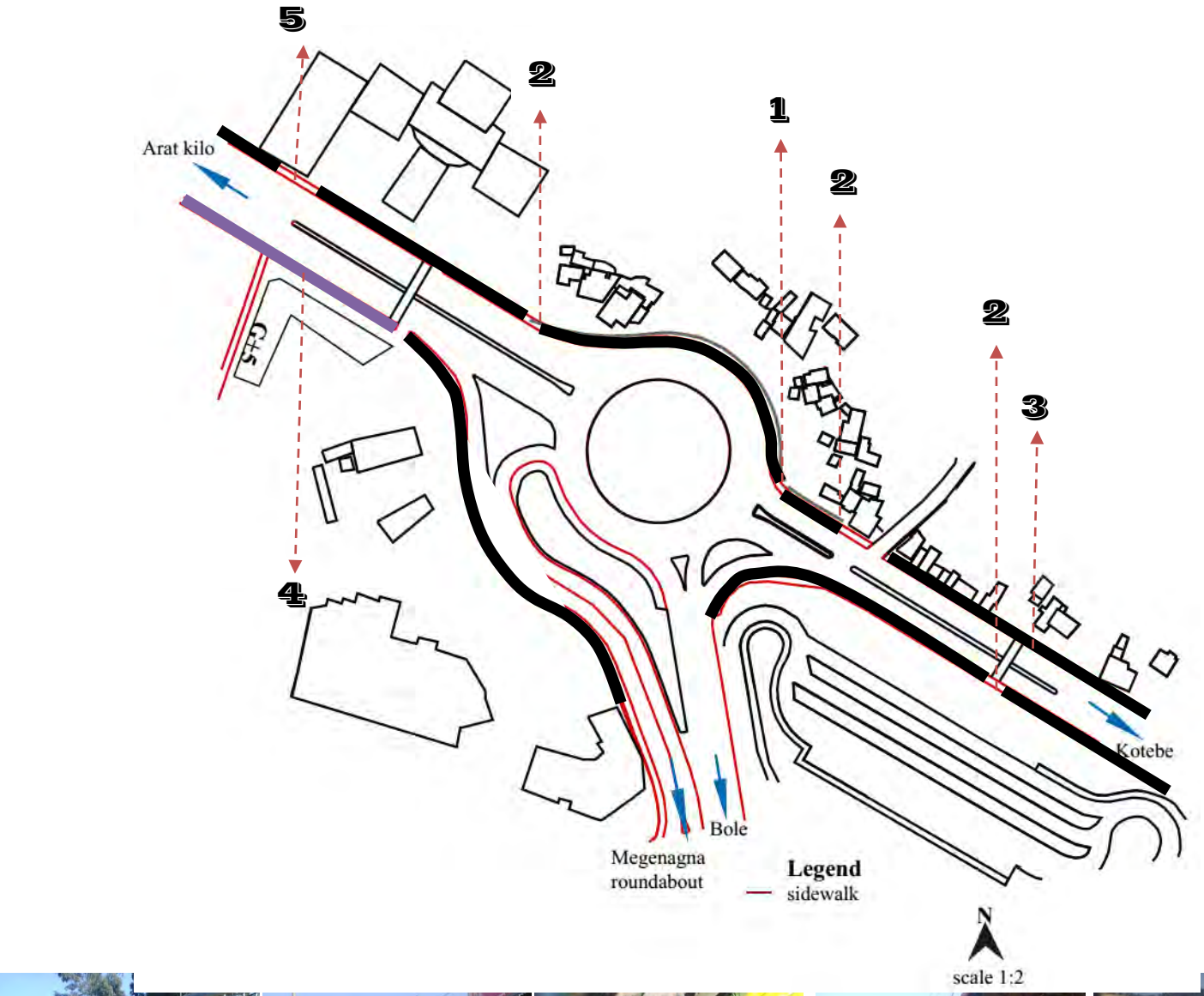
3 Bus ticket distribution shop

Figure 20. Continuity of sidewalk map with picture showing place lacking continuity (source; source; Addis Ababa structural road network map and edited based on survey and photo taken by; Senait Mohammed, 2006)

Diaspora roundabout has 60 % coverage of sidewalk related to length of traffic lane. This shows lack of continuity. Sidewalks are not continuous like the traffic lane because of the presence of drive ways curb cuts provided for car access to parking area provided in front, at back and adjacent to the buildings as well as due to privatization of pedestrian walkways to staircase development in order access individual building, waste disposed on sidewalk, the absence of well-maintained and managed utility and disorganized arrangements of different facility (see fig. 20). It affects people proper use of path using sidewalk and crossings provided.

1.2.1.2. Sidewalk connection with surrounding

At some part of the roundabout sidewalks are connected to the surrounding with stairs, a ramp, level that give access to neighborhood, terminal and building. But those connecting elements are in poor condition because of lack of maintenance. Other part of sidewalk has no connection because of the presences of permanent obstacles and blind fences. This reduces the connectivity of the roundabout.



1 Ramp 2 Poor condition Stair‘s 3 No connection 4 Level

Figure 21. Connectivity of roundabout with surrounding and the connecting elements (source; Addis Ababa structural road network map and edited based on survey and photo taken by; Senait Mohammed, 2006)

1.2.1.3. Perception of pedestrian on Sidewalk LOS and continuity

According to Park (2008) Pedestrian perception is one of the measurements of the Sidewalk LOS and continuity which is affected by over crowdedness of sidewalk and cars entering driveways. In order to measure pedestrian perception three questions asked which are adopted from Park.

In the questionnaires 150 different types of people participate to evaluate sidewalk LOS and continuity (see table 6 and fig. 22).

		almost always	usually	occasionally	rarely
step out of sidewalk to avoid other pedestrian	number of people	11	55	62	18
stop to avoid car entering driveway		55	63	14	18
feel uncomfortable because of crowdedness of sidewalks		36	62	33	19

Table 6. Perception of pedestrians on sidewalk LOS and continuity (source; questioners)

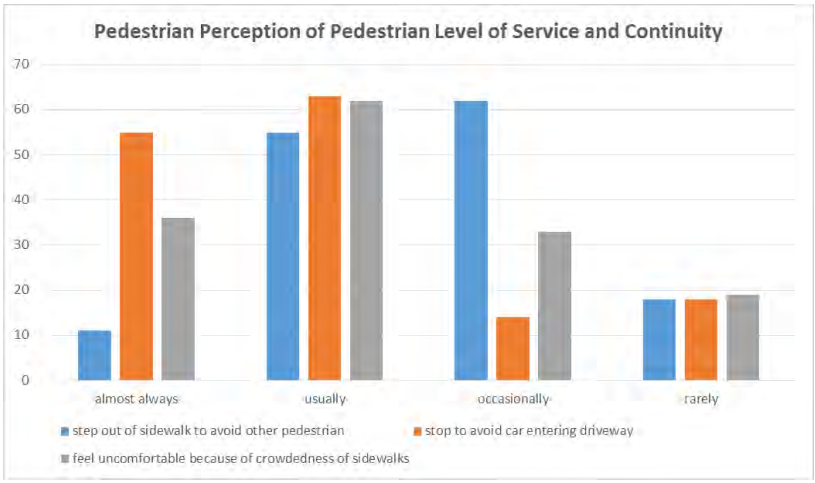


Figure 22. Pedestrian perception of LOS and continuity (source; questioners)

From the data collected from the 150 questionaries‘ made to analyze the perception of people about the roundabout related to the sidewalk LOS and continuity 44% always enter to driveway because of over crowdedness of walkway and other stay on sidewalk, 78 % of always stop to let car enter to driveway and others not, and also 65 % feel uncomfortable because of overcrowded sidewalks. In general it shows most of the time pedestrian coming to roundabout affected by car entering to driveways with respect to presence of pedestrian and over crowdedness of sidewalk. This show low level of LOS and continuity.

1.2.1.4. Intersection

According to Steiner (2004), number of intersection per area is one of the measurements of connectivity. If there is a high number of intersection it will be easy for movement.

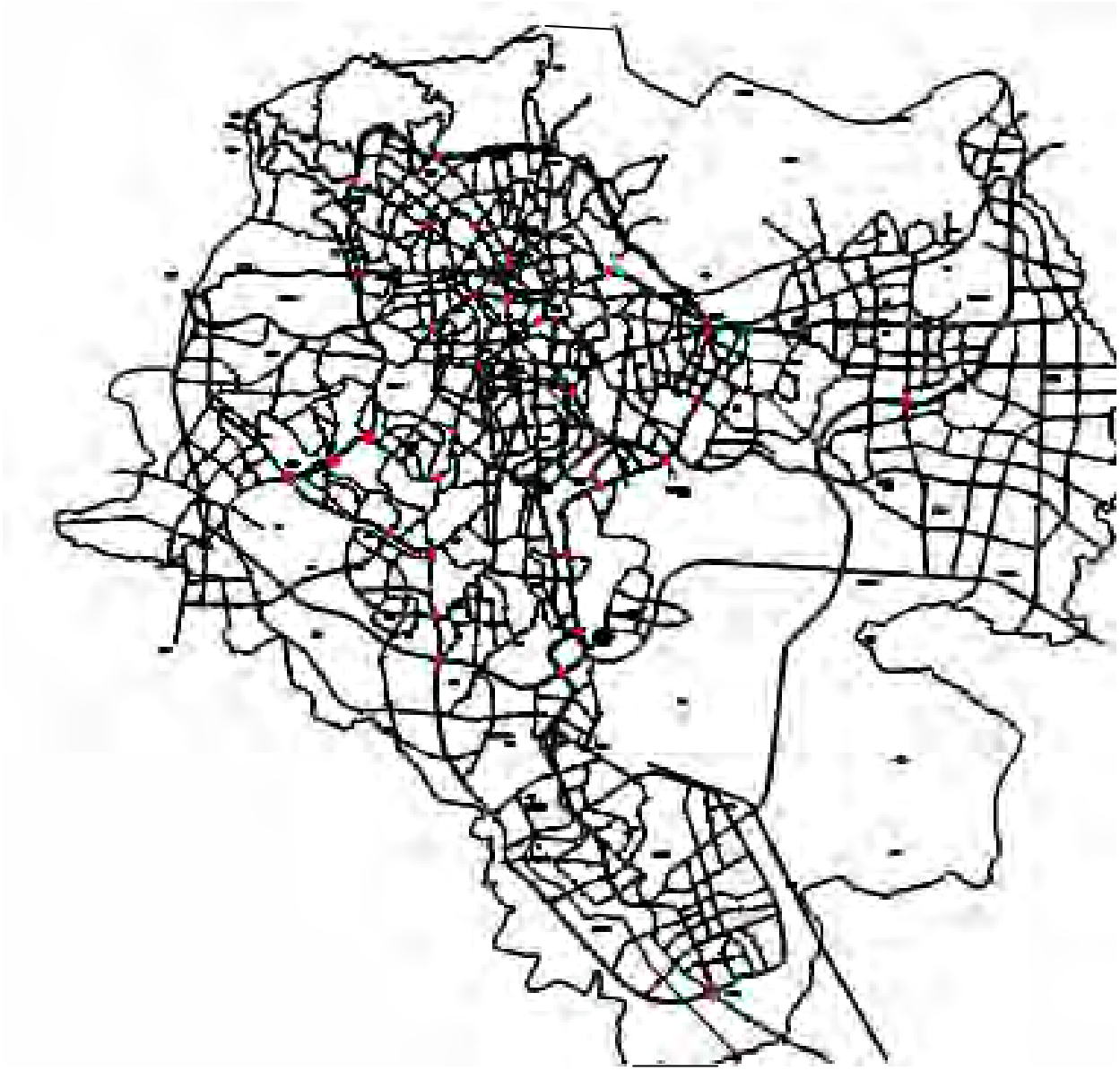


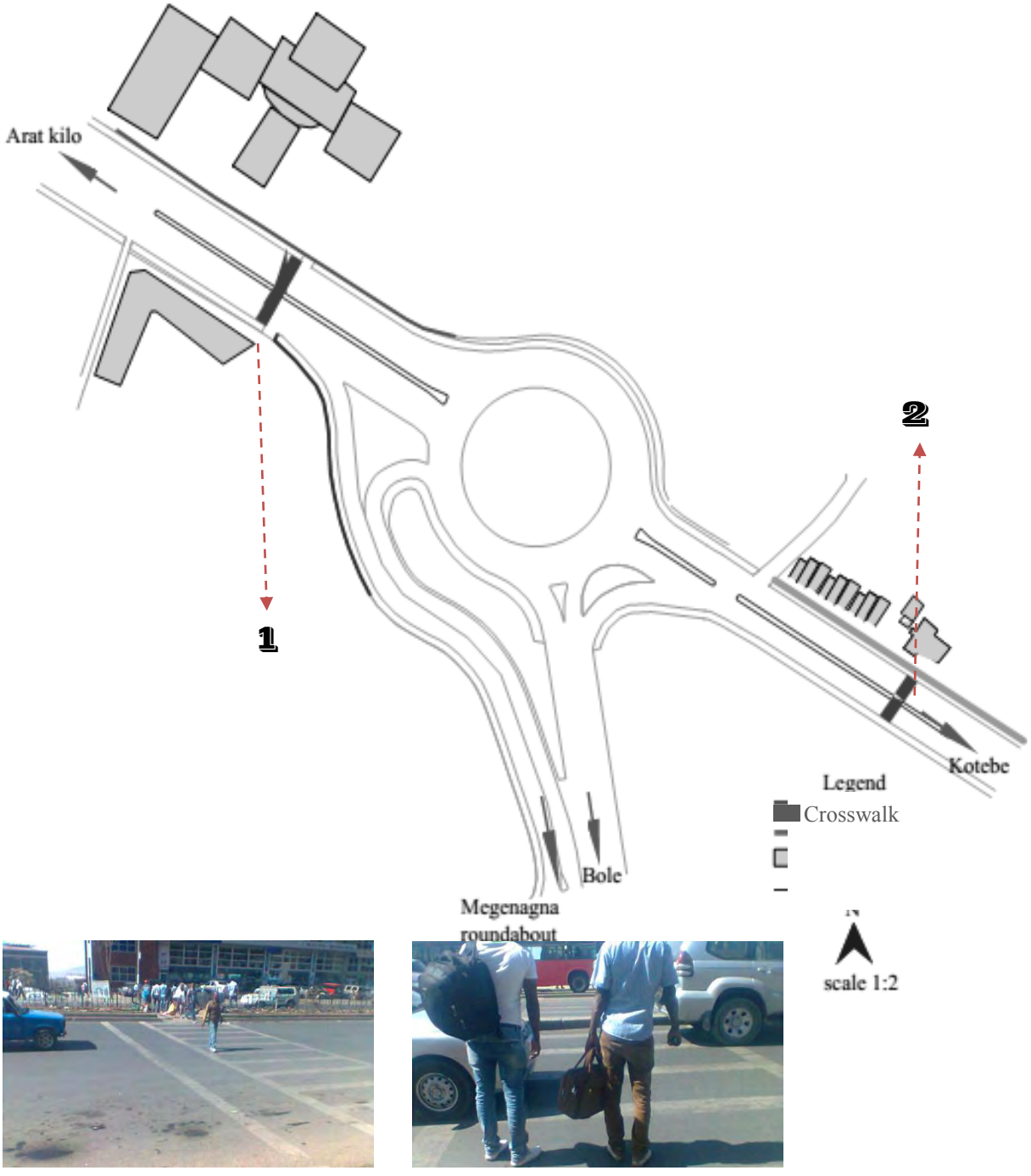
Figure 22. Connectivity of diaspora roundabout with other roundabout found in Addis Ababa

In the case of diaspora roundabout it is well connected with all the roundabout found in Addis Ababa that are located in major road network system which makes it highly accessible and well connected with other nodes.

1.2.1.5. Crossings

According to (Maghelal 2010), the number of crosswalks per intersection is one of measurement of connectivity.

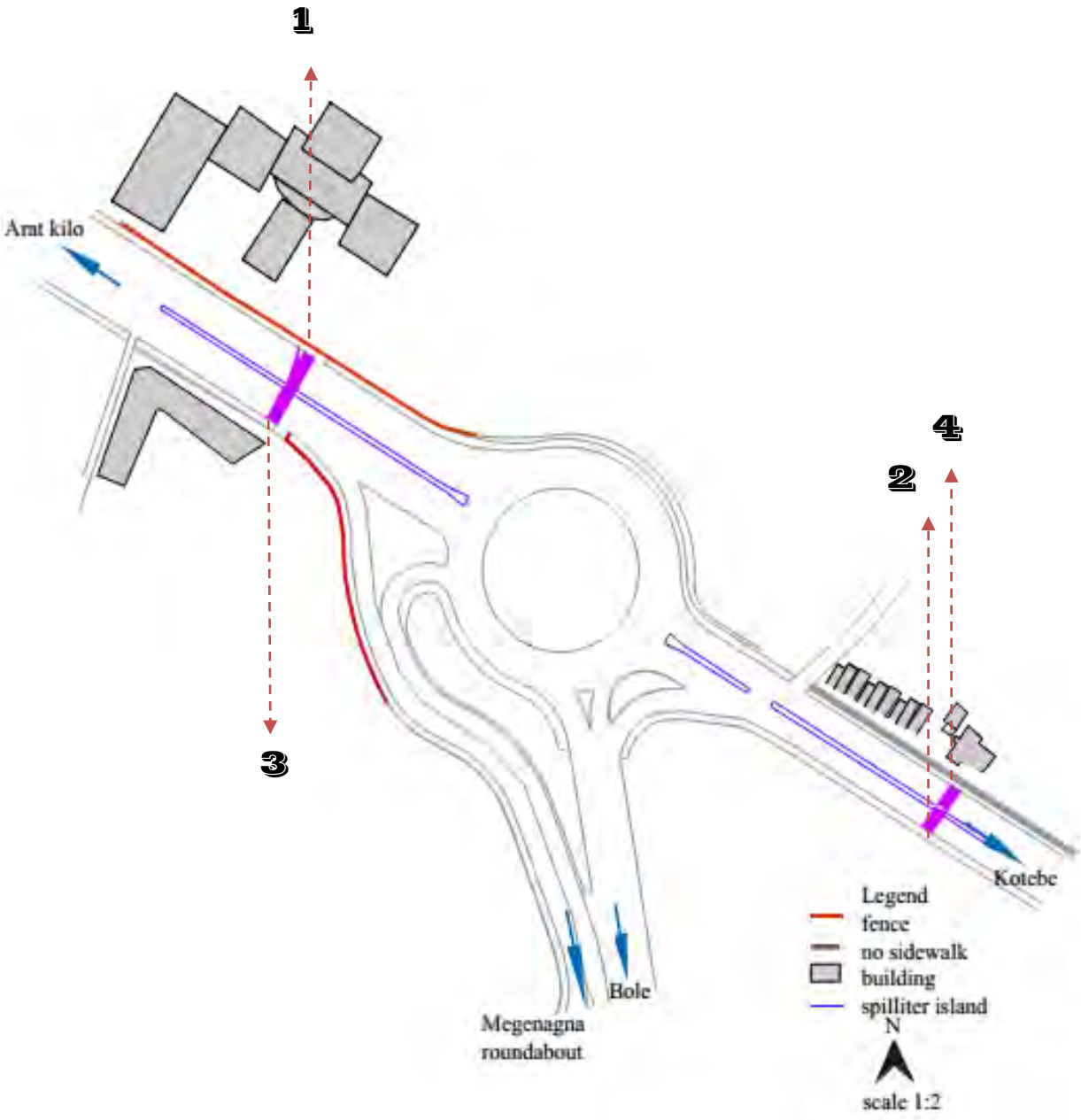
In order to analyze existing condition counting of crosswalk and measurement are taken using meter on each path connected to roundabout.



1 Zebra crossing on path takes to 4kilo 2 Zebra cross on path led to Kotebe

Figure 23. Existing crossings (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

Diaspora roundabout has four paths connected to it but there are only two zebra crossings found on the path that takes to Arat kilo and kotebe (see fig. 23) which show less connectivity and opportunity of crossings. It has the same length with traffic lane which is 28m and width of 4m. It is too long and takes an average of 8-10 sec and 18-20 sec waiting time to cross because of the presence of high number of lanes and absence of traffic calming element and pedestrian facility. This will make it crossing is difficult because people don't know when the car yield and also to observe movement of vehicles especially when there is high traffic flow. This affects the usability of crossings.



1 Fence, transport station and Open ditches

2 Stair led to Megenagna terminal

3 Parking lot and driveway curb cut

4 Access to individual building

Figure 24. Location of crossing and their connectivity to surrounding (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

Crosswalks also located in inappropriate location where pedestrian feel unsafe. The first crossing found at path that takes to Arat kilo located 7.7 m away from edge of circulatory carriageway and takes immediately to parking lot, driveway curb cut, open ditch and station where there is no development, taxi and bus stops. The other one that is found on the path that led to Kotebe at 12m away from edge of circulatory carriageway and takes to area where there is no sidewalks because of privatization of sidewalk for access to individual and led to Megenagna terminal access way(see fig. 24). This show lack of connectivity with the surrounding environment and sidewalks. They are less visible because the painting is not well maintained and the presence of taxis and bus station between crossing and circulatory carriageway.

1.2.1.6. Urban Pattern

Connectivity can be measured using the existing physical environment which includes travel distance and block length.

1.2.1.6.1. Block Length

According to Handy et al. (2003), Block length is one of measurement of connectivity of urban pattern. Several communities have adopted maximum block length standards for new development which range from 300 to 600 feet and apply to every block, with some exceptions. Block lengths can be measured from the curb or from the centerline of the street intersection. The shorter blocks mean more intersections, shorter travel distances and a greater number of routes between locations. So shorter length is advisable for pedestrian and bicycle connection.

Figure 25. Length of block surrounding the roundabout (source; Addis Ababa GIS map edited by; Senait Mohammed, 2006)

From analysis made on GIS Diaspora roundabout is surrounded by blocks having block length >183m (see fig. 25). This show the site lack connection because of existence of larger blocks which has impact on increase trip length and reduce walkability.

1.2.1.6.2. Pedestrian route directness

According to Steiner et al 2004, pedestrian route directness is one of measurement of connectivity of urban pattern which is a proportion of actual distance and travel distance and has value 1.2-1.7 then that area is highly connected.

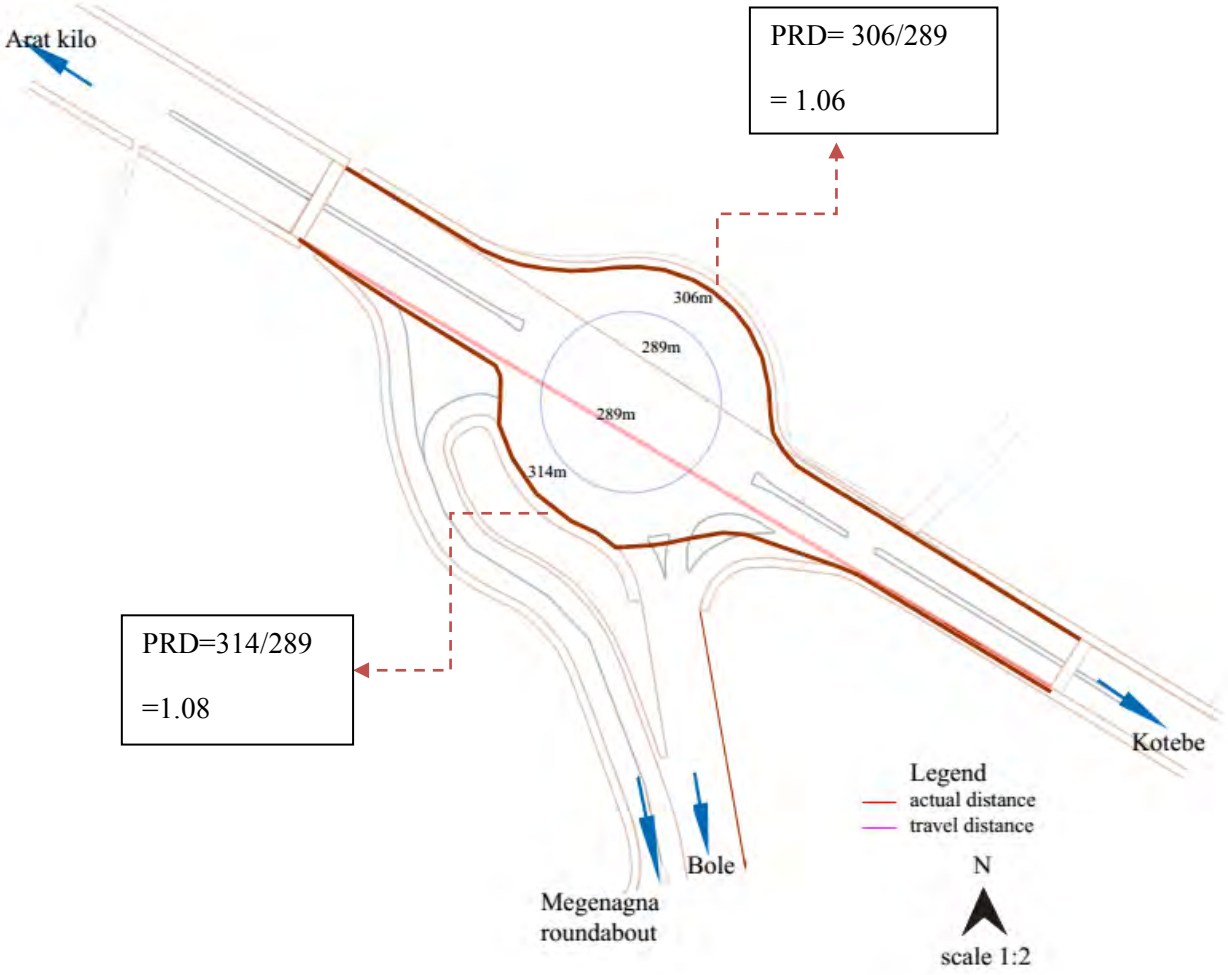
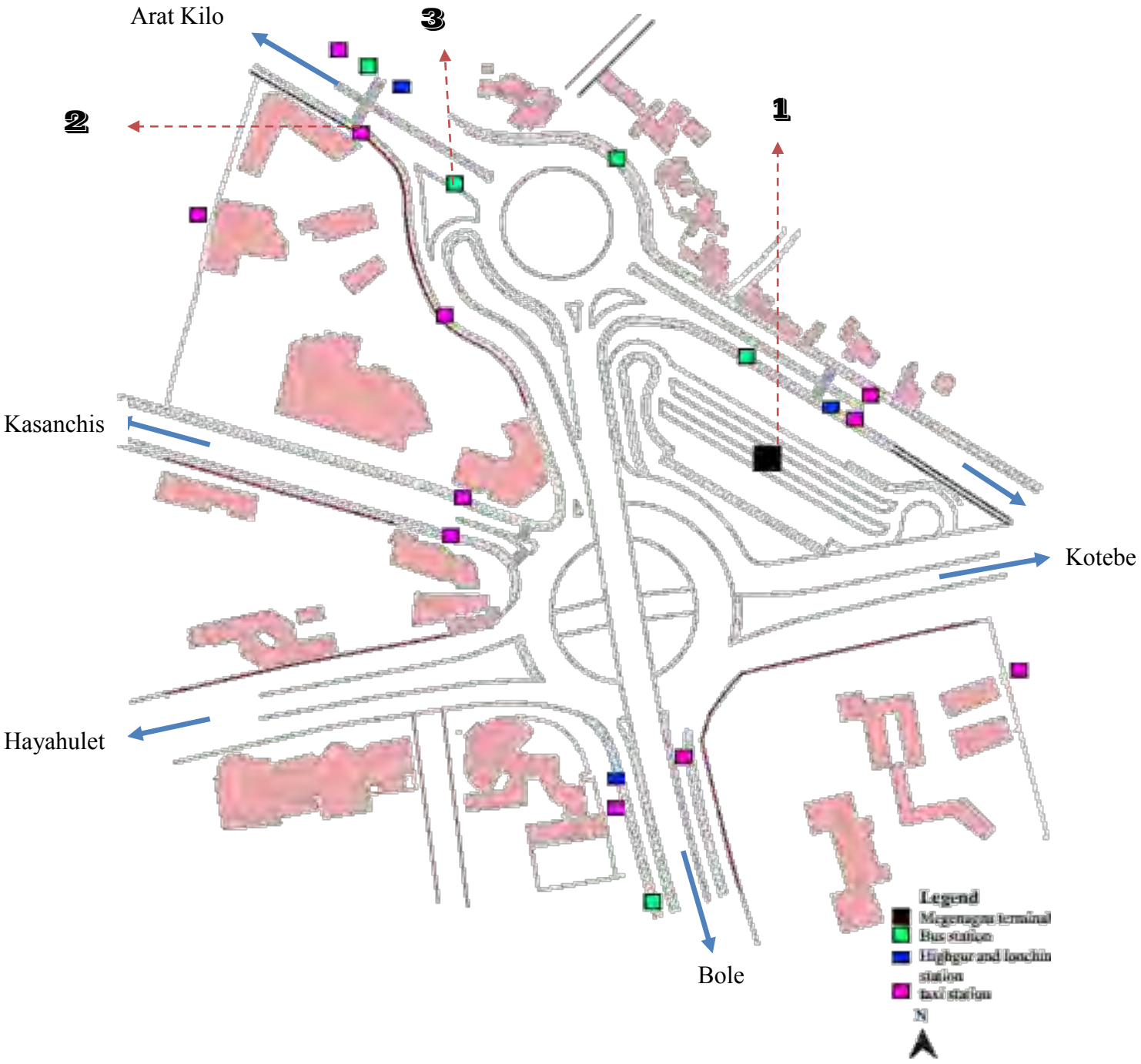


Figure 26. Pedestrian route directness (source; Addis Ababa structural road network map edited by; Senait Mohammed, 2006)

From the measurement made on actual and travel distance made between crossings on roundabout the pedestrian root directness has a value of 1.08 and 1.06 (see fig. 26) which is less than standard because people travel more than they need to travel and there travel distance also affected by the presence of many traffic lanes connected to roundabout as well as geometry of junction. They travel relatively 400m which is 5min walking distance. So if the people live and work within 10 min walking distance radius walk an additional trip length on roundabout which led to delay of time and discourage people presence and walking experience.

1.2.1.7. Gateway

According to Soltani & Allan (2005), the presence of public transport within 200m buffer is a covenant distance every people can walk. The roundabout has different public transportation facilities around it within 200m-400m radius. In order to analyze the connection of roundabout with public transport location of transport nodes like bus, taxi and other transport stations and terminals found within 200m and 400m radius are mapped .



1 Megenagna terminal 2 Taxi Station 3 Bus stop

Figure 27. Public transport stations and terminals found within 200 and 400m radius from roundabout (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

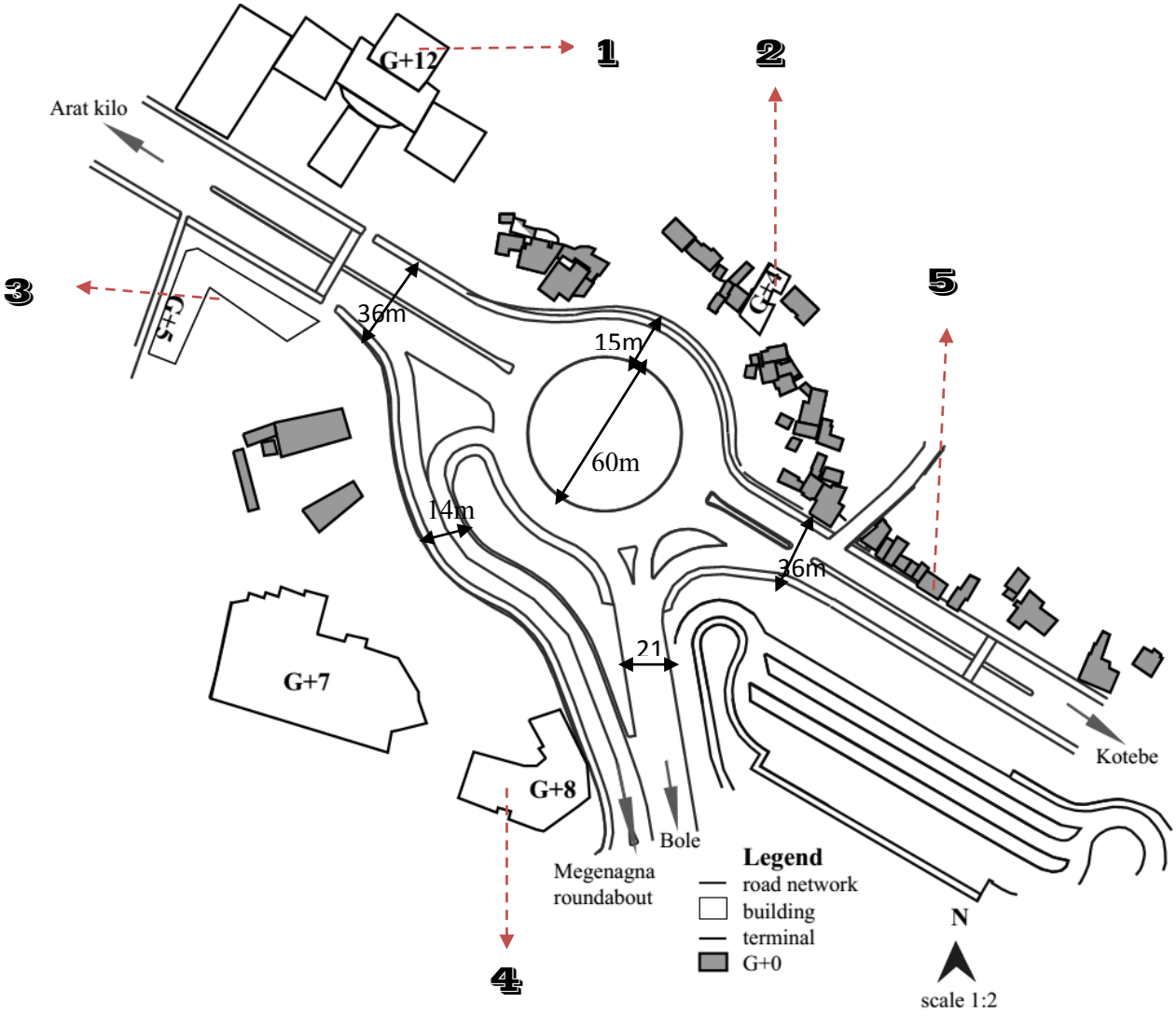
From the data collected within 200 m radius of diaspora roundabout there are different transportation center which includes Megenagna terminal which is one of the largest transport node with variety of choices of public transportation that generate high flow of people. In addition to that there are also 8 taxis sations, 5 bus stations and 2 lonchin & hygur stations. They are found adjacent to roundabout in front of Hundai and under construction yeka sub city building as well as in front of Megenagna and Metebaber building as well as within circulatory carriageway. There are also 3 taxi stations, one bus station, LRT and 2 lonchin & hygur station within 400m distance (see fig. 27). Those transport station connect the site with Arat kilo, Piassa, Bole, Kotebe, CMC/Hayat, Kasanchis, Mexico, Gerji, Yerer/Goro, Saris Abo and so on. This makes the site accessible and well connected to public transport system as well as to the other part of city. But their location is inappropriate because they affect proper operation of roundabout and hinder roundabout and pedestrian visibility at crosswalks.

1.2.2. conspicuous

According to Park (2008) conspicuous can be measured by the ***enclosure, pedestrian sign coverage and perception of pedestrians***. They are measured by different variables which include street width, building height, set back and number of pedestrian crossing with signal.

1.2.2.1. Enclosure

In respect to scale 3 story (30 foot) building with 36 foot building width maximum is the human scale. According to Jacob height to street width is best if its 1:3.3 and 1:2 ratio has strong sense of enclosure but if it is 1:5 the enclosure will be weak. The setback don‘t has to be >70 feet if it is more than that it will be taken as vacant lot.



1 Yeka sub city under construction building

2 mixed used building

3 Maraton motors building

4 poor quality building

5 Metebaber building

Figure 28. Size of setback, traffic lane and building height and their relation (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

1.2.2.2. Pedestrian sign coverage

There is also no sign for pedestrian crossings which show were to cross and were the path led to. It led to confusion/clear understanding of the path and use of inappropriate places. But signs for driver are provided which show the presence of roundabout, no turning and directions were the path it takes.

1.2.2.3. Pedestrian perception of conspicuous

According to Park (2008) pedestrian perception of conspicuous is one of measured by sense of scale and enclosure, visual attractiveness and visual variety.

1.2.2.3.1. Sense of scale and enclosure

According to Park (2008) pedestrian perception of conspicuous is one of measured by sense of scale and enclosure which is affected by sizes of building, building height, street width and streetscape. In order to measure pedestrian perception four questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate sense of scale and enclosure (see table 7 and fig. 29-32).

size of building	too big	somewhat big	I like them just the way they are	somewhat small	too small
number of people	0	16	30	88	16
size of building height	too tall	somewhat tall	I like them just the way they are	somewhat short	too short
number of people	0	35	69	27	19
size of street width	too wide	somewhat wide	I like them just the way they are	somewhat narrow	too narrow

number of people	0	29	58	47	16
feeling of the roundabout	too enclosed	somewhat enclosed	I like it just the way it is	somewhat expansive	too expansive
number of people	12	14	77	47	0

Table 7. The number of people responds for each question on sense of scale and enclosure (source: questioners)

Figure 29. Perception of pedestrians on scale and enclosure (source: questioners)

Figure 30. Perception of pedestrian on street width (source: questioners)

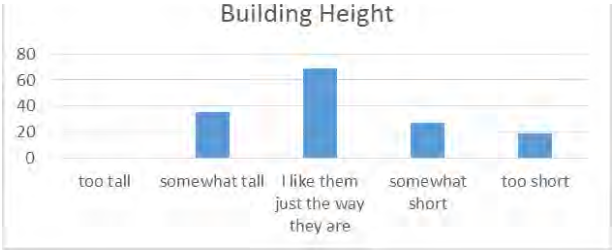


Figure 32. Perception of pedestrians on building height of surrounding environment (source: questioners)

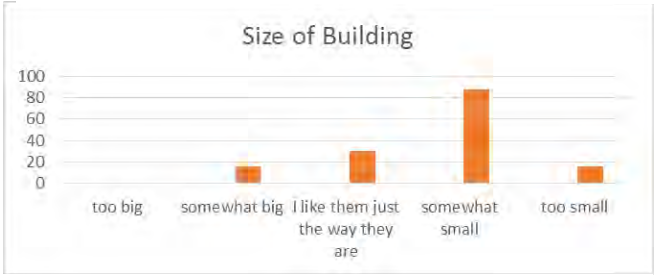


Figure 31. Perception of pedestrian on size of building (source; questioners)

From the data collected from the 150 questionaries‘ made to analyze the perception of people about the roundabout related to scale and enclosure 69% of them feel buildings size is small, 20% like there size and other 11% fell they are big. From building height perspective 31% feel short, 46% like them as they are and 32 % feel they are tall. In general higher number of people like the size and height of existing building found around the roundabout. They also evaluate street width and streetscape from the entire participant 42% feel it is narrow, 38% like them as they are and 20 % feel it is wide in addition to that 31% feels streetscape is expansive, 51% like it and other 18 % feel it is enclosed. This show most people like the existing urban pattern.

1.2.2.3.2. Visual attractiveness

According to Park (2008) pedestrian perception of conspicuous is one of measured by visual attractiveness which is affected by landscaping and also the streetscape. In order to measure pedestrian perception two questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate visual attractiveness (see table 8 and fig. 33-34).

feeling about the amount landscaping of the trees	plenty	enough	not enough	hardly any
number of people			40	110
feeling of roundabout	very attractive	somewhat attractive	unpleasant	ugly
number of people			106	44

Table 8. Perception of pedestrians on visual attractiveness of roundabout (source; questionaries‘)

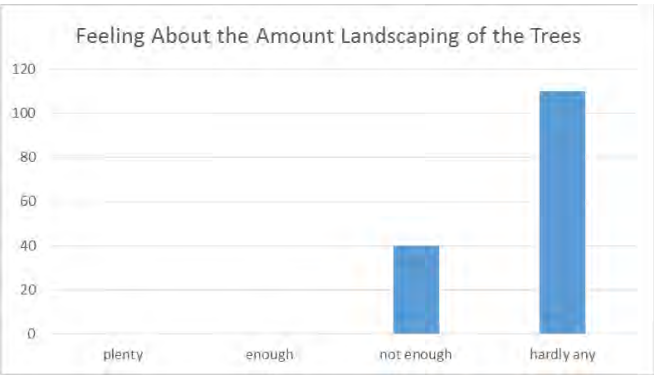


Figure 34. Perception of pedestrians on amount of landscape found in roundabout (source; questioners)

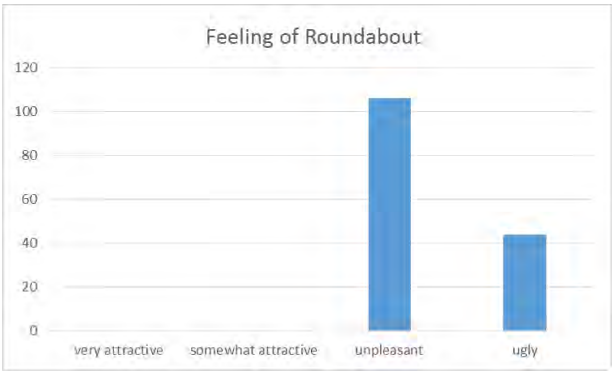


Figure 33. Perception of pedestrians about roundabout (source; questioners)

From the collected questionaries‘ the entire participant feels there is no landscaping element and the roundabout is also not attractive.

1.2.2.3.3. Visual variety

According to Park (2008) pedestrian perception of conspicuous is one of measured by visual variety which is affected by the presence of interesting thing to see. In order to measure pedestrian perception two questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate visual variety (see table 9 and fig. 35-36).

presence of interesting to see	yes, plenty	yes, enough	no, not enough	no, hardly any
number of people	8	11	73	58
feeling of streetscape	very dull	somewhat dull	somewhat interesting	very interesting
number of people	73	51	23	3

Table 9. Perception of pedestrians on the presence of variety thing to see (source; questioners)

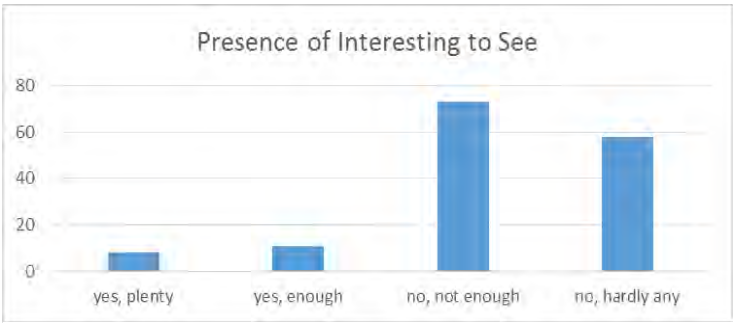


Figure 35. Perception of pedestrians on presence of interesting to see (source; questioners)

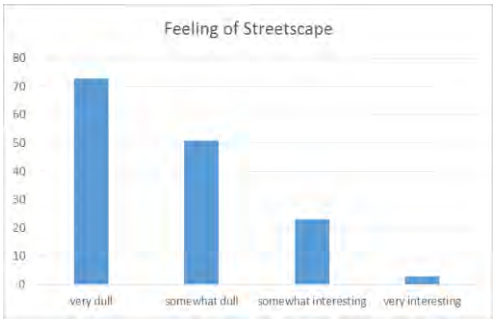


Figure 36. Perception of pedestrians about streetscape (source; questioners)

From the collected questionaries‘ the 87% said there is no interesting thing in the roundabout and 82% of participant feels it is dull.

1.2.3. Convenience

1.2.3.1. Land use mix

According to Frank (2005) land use mix is one of measurement of convenience that can be calculated using formula written below and it has value range from 0 to 1. If the LUM has 0 values it shows there is only one kind of land use but if it has value of 1 then that area will have balanced mix of all uses.

P_i = proportion of sq. ft of land use; n = number of land use $-\left[\left(\sum_{i}^{n}(p_i)\ln(p_i)\right)/\ln(n)\right]$

In order to analyze land use mix of diaspora roundabout existing land use collected and analysis made using GIS. 11.62, 1.2, 1.94

OID	LU_2	area	A _At	ln A _At	A_At_lnA _A
1	Administration	1.4	0.12	-2.12	-0.25
2	commercial	3.46	0.3	-1.2	-0.36
3	green	0.42	0.036	-3.32	0.12
4	mixed residential	0	0	0	0
5	residential	0.23	0.02	-3.9	0.078
6	road network and parking space	6.4	0.55	-0.6	0.33
7	vacant space	0.17	0.0146	-4.23	0.062

Table 10 . Land use mix (source: GIS landuse map edited by senait mohammed,2006)

Land use mix= ∑A_ At _In A _A/In 14=1.2/In 7= 0.6

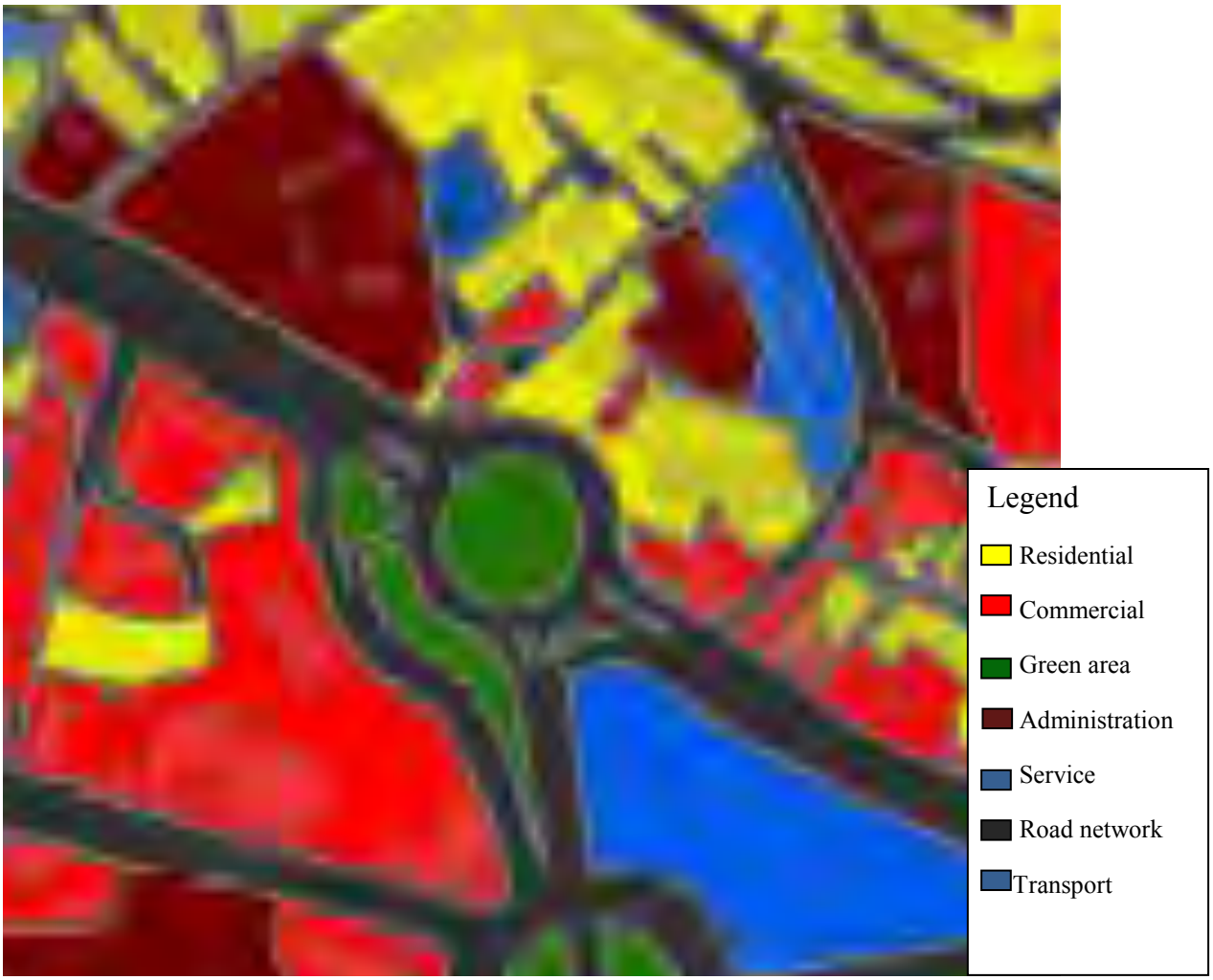


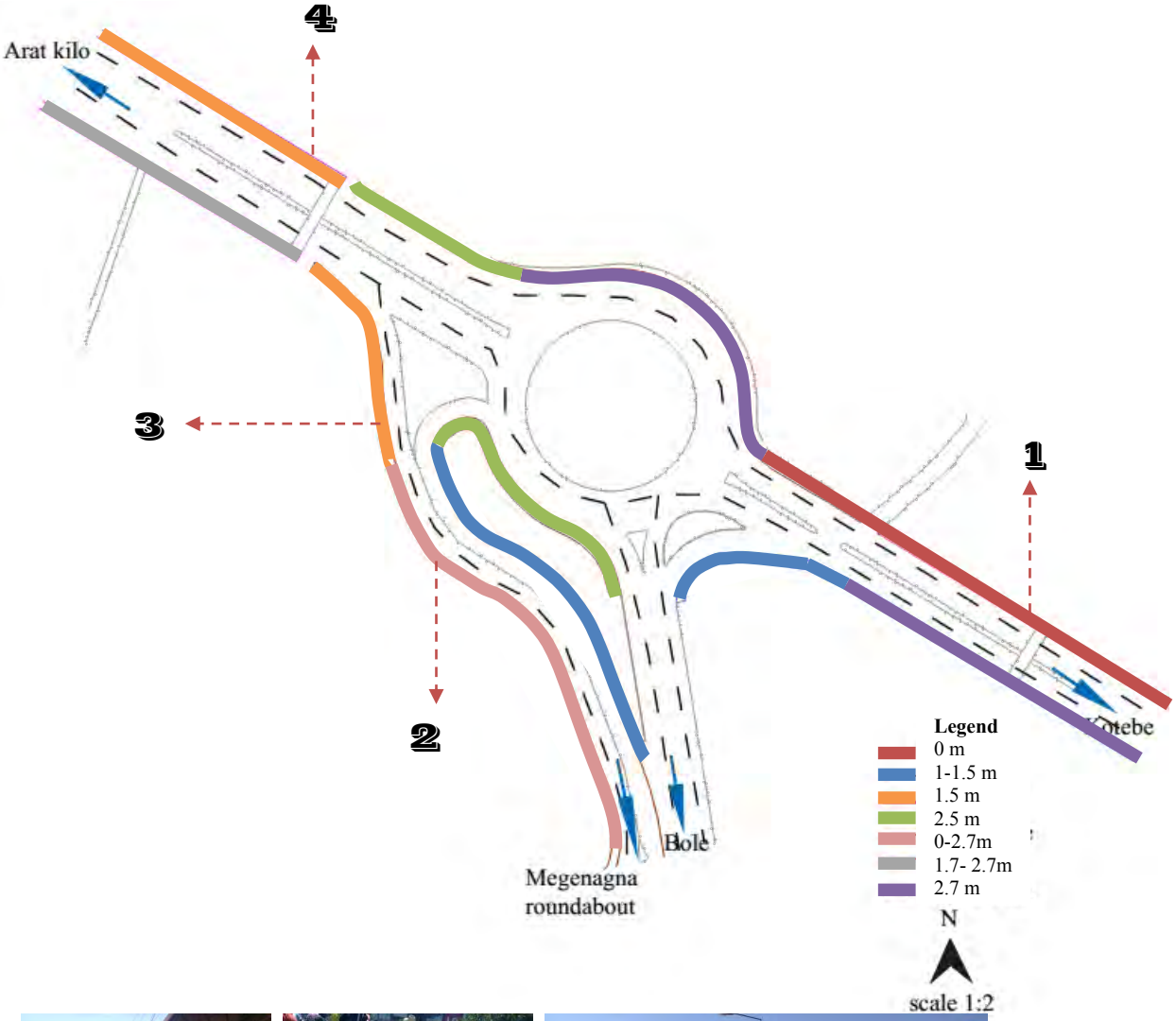
Figure 37. Land use distribution (source; GIS landuse map edited based on survey by senait mohammed, 2006)

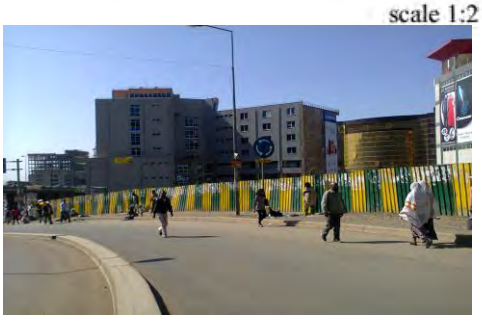
Based on the analysis Diaspora roundabout has a value 0.6(see table 10). This shows the imbalance of use because the area is large parking areas, dominated by vacant space, terminal and road network than building which provide variety of function (see table 10). It also show dispersed development and segregation of land use which discourage walkability and presence of people. This makes the roundabout low density car oriented environment were developments give emphasis to cars than for public space.

1.2.3.2. Sidewalk

According to Krambeck (2006), Convenience of sidewalk can be measured by the existence of blind and disabled facilities, maintenance and cleanness of walking path, average sidewalk width and obstacles on walking path.

In order to apply those measurements sidewalks measured at different point by neglecting those spaces occupied by street furniture‘s, street vendors and shoe polish.





1 Stairs on sidewalk

2 Street vendor and Street light

3 Utility

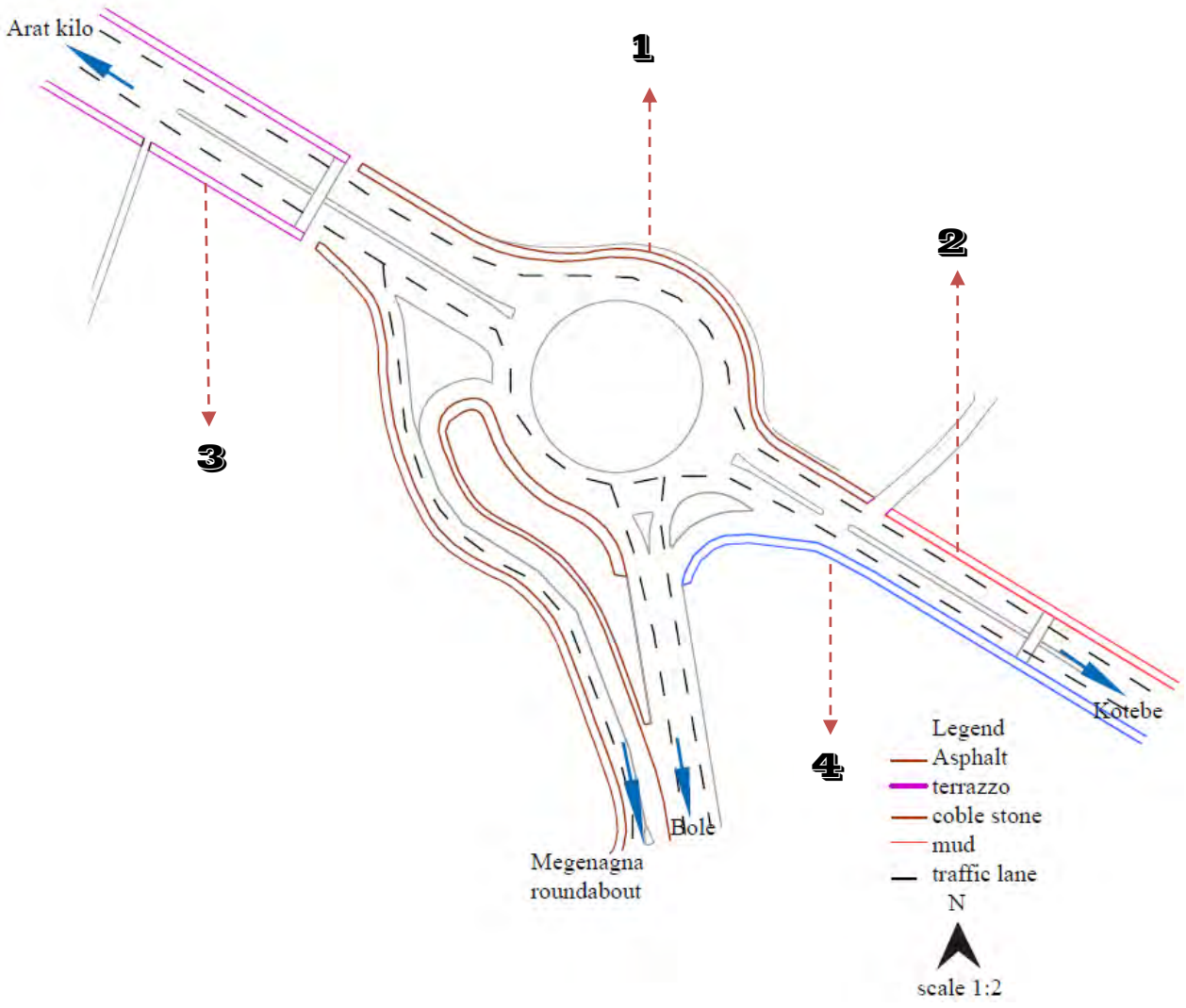
4 Shoe shine boy

Figure 38. Average sidewalk width and picture showing factor for variance of size of walkways (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed)

The sidewalks found around the roundabout have width of 1.3-3 m which is more or less enough related to minimum clear passage of 3ft width. But its width vary because of the presence of different permanent and temporary obstructions like failed poles, open ditches; board, bus ticket shop, poles, streetlight, street vendors, stairs and shoe shine (see figure 38). The presence of those reduces its clear width to 0-2.7 m. This make site not fit with the need and led to overcrowded environment. The over crowdedness of the sidewalk expose pedestrians to crime, force to get into traffic lane which increase pedestrian vehicular conflict and increase time taken to arrive their destination.

1.2.3.3. Pavement material of sidewalk

The sidewalks are paved with asphalt, terrazzo, concrete and gravel (see figure 39). Those paved with asphalt and gravel has low quality, less smoothness and less attractive because of lack of maintenance and missing pavement which led to accident like falling, losing balance and create uninteresting environment. The other part of sidewalk covered with terrazzo, concrete has good and well maintained quality, more or less smooth texture, attractive color and pattern with few missing pavement.

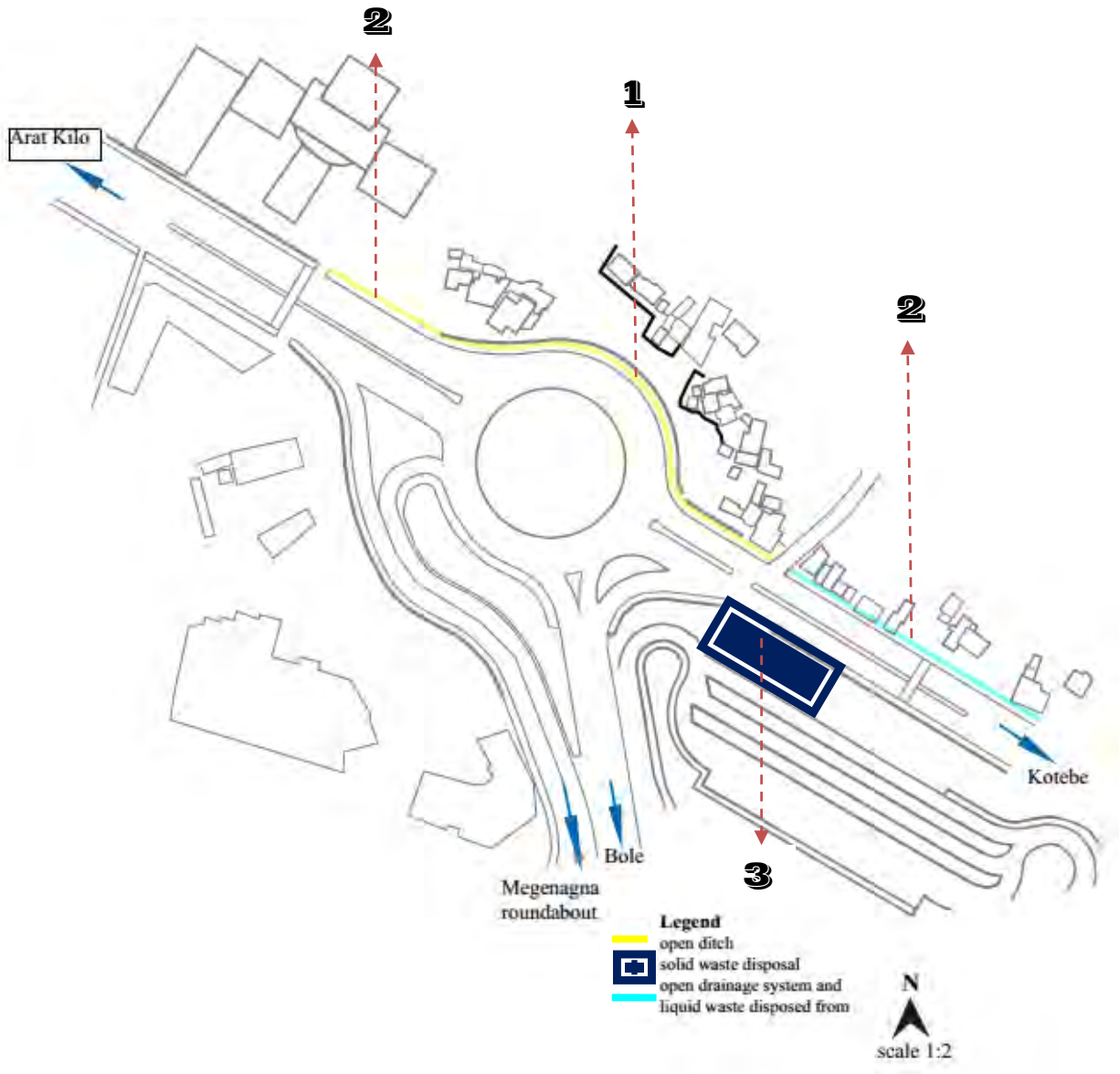


1 Asphalt pavement 2 Mud pavements 3 Terrazzo 4 Concrete pavement

Figure 39. pavement material of sidewalk (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

1.2.3.4. Cleanness of the roundabout

The sidewalks of diaspora roundabout are not clean because it exposed to bad odor coming from open ditches, detritus on vacant land, liquid waste from under construction site and waste disposal inside Megenagna terminal (see figure 40). This affects the health and easy movement of people. In order to avoid those people prefer to share traffic lane. This led to accident as well as the abundance of the area.



1 Open ditch 2 Liquid waste disposed on sidewalks 3 Solid waste disposal areas

Figure 40. Unclean part of roundabout (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

1.2.3.5. Pedestrian facility

The roundabout also lacks pedestrian facility especially for blind and disabled people like curb cuts, ramp which provides easy access to area as well as to identify crossing location. Even the surrounding developments are not accessible to those people because most of building and neighborhood accessed by stairs. But at some place tactile pavement are applied using terrazzo having straight line pattern colored with yellow at middle of pedestrian sidewalk but it led to unsafe location; taxi station and driveway curb cut. It affects the safety of disabled people.

1.2.3.6. Pedestrian perception of on convenience

According to Park (2008) pedestrian perception of convenience is measured by easiness of pedestrian crossing and easy access to local store.

1.2.3.6.1. Easy of pedestrian crossing

According to Park (2008) pedestrian perception of convenience is one of measured by easiness of crossing affected by pedestrian waiting time at crossing and their feel about crossing. In order to measure pedestrian perception two questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate easiness of pedestrian crossing (see table 11and fig. 31-42).

feeling of waiting too long to cross	almost always	usually	occasionally	rarely
number of people	18	76	55	1
feeling of crossing	very difficult	somewhat difficult	pretty easy	very easy
number of people	14	124	12	0

Table 11. Perception of pedestrians on easiness of crossing (source; questioners)

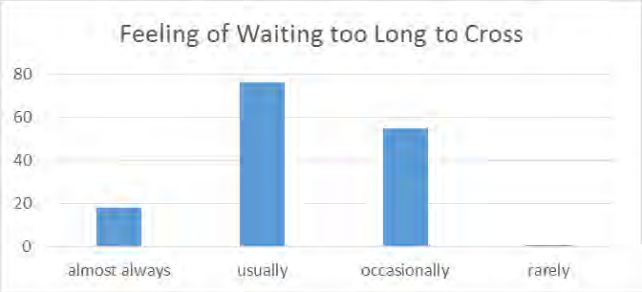


Figure 41. Pedestrians feeling of waiting too long at crossing (source; questioners)

Figure 42. Pedestrians feeling of crossing at roundabout (source; questioners)

From the data collected from the 150 questionaries‘ made to analyze the perception of people about the roundabout related to the presence of pedestrian crossing 62 % of them they have to cross for longer time to cross and 90% of people feel crossing is difficult. In general people feel crossing at crosswalk is difficult because it takes longer time interval.

1.2.3.6.2. Easy access to local store

According to Park (2008) pedestrian perception of convenience measured by easy access to local store which is affected by the availability of stores and other service. In order to measure pedestrian perception one questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate easy access to local store (see table 12 and fig. 42).

presence of stores and available services	yes, plenty	yes, enough	no, not enough	no, hardly any
number of people	5	55	76	14

Table 12. Perception of pedestrians in the availability of services (source; questioners)

Figure 42. Perception of pedestrians in the availability of services (source; questioners)

From the collected data 60% of the people said there is lack of facilities and the other 40% enough feel there is enough facility provided there. But from larger perspective there is a lack of variety of function which provides different facilities.

1.2.4. Comfort

1.2.4.1. Sidewalk

According to Maghelal (2010), Landis (2001) and Gallin 2001), comfort of sidewalks can be measured by buffer width and location of sidewalk and surface quality respectively.

Based on site observation the sidewalks are raised sidewalk found directly adjacent to traffic lane with a height of 30cm level difference without any buffer or any kind of special treatment to make them visible and safe. This accelerates fast movement of traffic and reduces safety. They are paved with terrazzo, asphalt, gravel and concrete and have low quality because of lack of maintenance. They also exposed to direct sun and rain, wind and fast moving traffic because of absence of buffer that can provide physical and psychological buffer from fast moving traffic. This also makes the site unattractive, uncomfortable and unsafe.

1.2.4.2. Amenities

According to Krambeck (2006) comfort also measured by the amenities provided which includes benches, public toilet, and way finding sign.

Diaspora roundabout has a little number of amenities which includes streetlight, directional and transport station indicator sign, traffic signs like yield sign, no turning and parking sign (see fig. 42). But they are supportive to cars because they face toward the traffic lane, give service to car users and also they are not human scale. Other than those amenities there is no other furniture like pedestrian light, benches and shades, public toilets, garbage can, information board, way finding sign, pedestrian sign which makes sidewalk less visible at night, unattractive because of information posted on fences and poles, exposed to direct sun light, wind & rain and full of detritus. This will discourage people presence and comfort.

No parking and station signs

Information board of origin-destination of transport modes as well which transport one give service at that point

Slow down sign

Parking is not allowed

Direction signs

Direction sign and streetlight

Figure 43. Amenities found in the roundabout (source; Senait Mohammed, 2006)

1.2.4.3. Sense of security

According to park (2008), Evans (2009), Maghelale (2010) and Krambeck (2006), comfort can be measured by sense of security which related to number of windows facing to roundabout which provide visual and auditory access to sidewalk, presence of boarded up buildings and unused plots, lighting and personal security or number of crime. It can be also measured by people perception of security from crime.

In order to analyze the exposure of roundabout to security problem recorded crime data from police station, abounded spaces, number of upper level window data, façade treatment, and streetlights presented at roundabout is collected through observation and count.

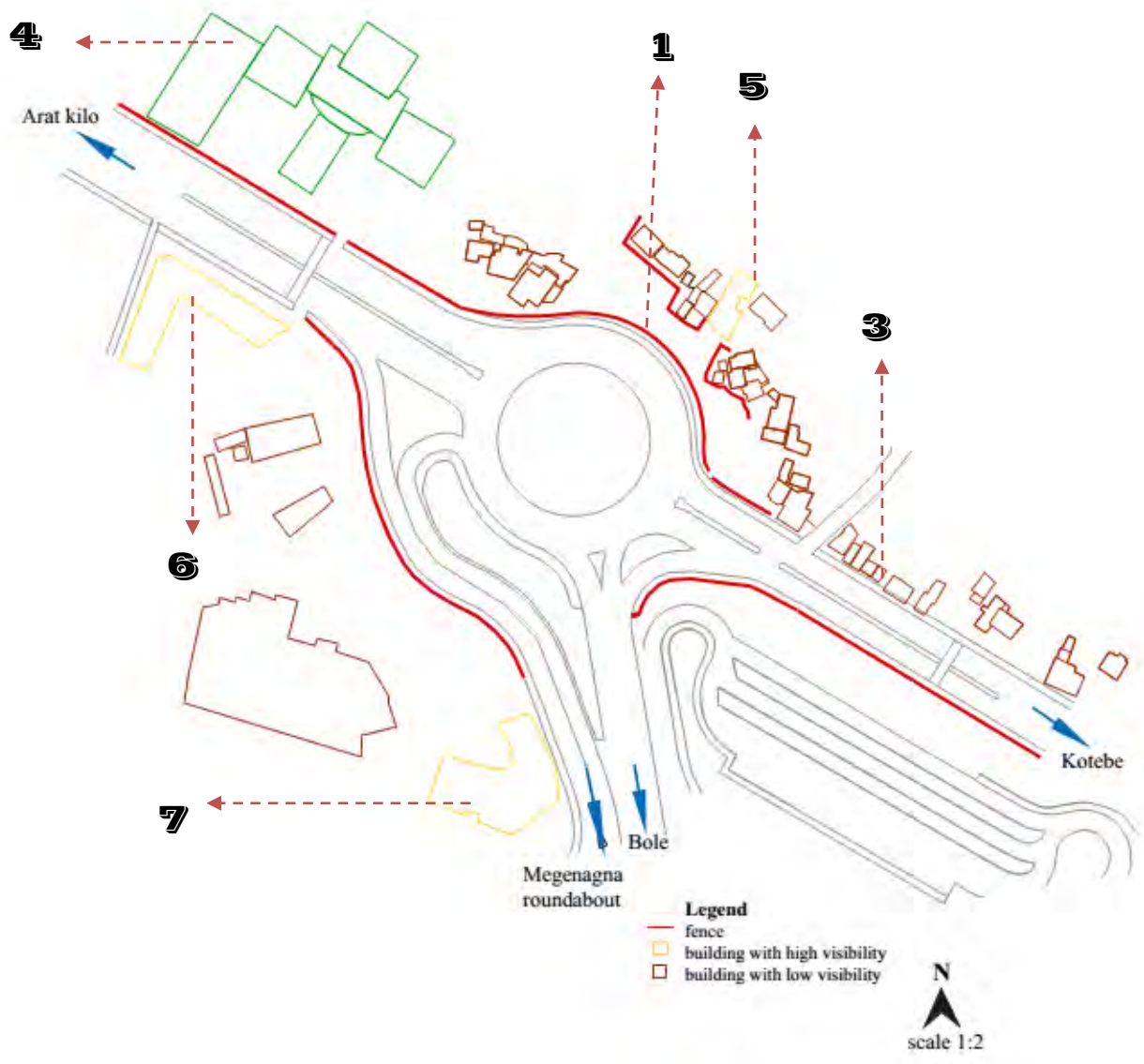
crime occur at diaspora roundabout from 1/11/2004 – 30/10/2006	
from 1/11/2004 to 30/10/2005	1-Day -3/13/2005 Time- Day 1200 profile of pedestrian; Sex- male Age-20 Education Level-10 marriage status-unmarried Employment- student Place of crime- kebele 13/14 near Hundai bldg. Mugger- two male Age-16 & 18 Education level-5 & unknown Employment -unemployed & unknown unmarried & unknown Type of crime- mugging 2-Day; 2/10/2006 Time- night 1800 Profile of pedestrian; sex- m Age-23 Educational level- 8 Marriage status- married Place of crime; Kebebe 13/14 Metebaber bldg Mugger; sex- male Age- 26 Educational level- iliterate marriage status-married Type of crime-mugging
from 1/11/2005 to 30/10/2006	0

Table 14. Crime data (source; yeka sub city police station)

From the crime data collected from Yeka police station with the period of 1/11/2004 to 30/10/2006 there are only two crimes occur within two years and it rate reduced from 2-0%. This data shows the absence of crime in the roundabout (see table 14).

1.2.4.4. visibility of the roundabout

Based on the collected data through observation the roundabout is surrounded by environment characterized by large abandoned vacant and parking space, buildings bounded by large fence, low rise poor condition shops, under construction buildings and absence of activity at night, large parking area in front of buildings, street light and few medium rise building with good visual connection which is not human scale facing the traffic lane (see figure 44). The presence of those will affect the visibility and security of roundabout. This reduce the perception of sense of security of people.



1 Vacant abundant space and low rise fenced residence

2 Large fenced areas

3 Poor condition shops

4 under construction building

5 mixed use building having 10 windows facing toward the roundabout

6 Metebaber building, has 20 windows facing to roundabout

7 Maraton buildings, has 27 and 12 number of window facing toward path connected to roundabout and roundabout

Figure 44. Visibility of roundabout by surrounding building (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

1.2.4.5. Weather / Climate

According to Maghelal (2010), comfort can be measured by its weather condition using amount of shade and rain cover provided by trees. The roundabouts don‘t have an area which is covered by trees that provide shade from direct sunlight, rain, wind, sound and air pollution which make it uncomfortable (see fig. 45). Even the surrounding developments don‘t provide shade because buildings are far from sidewalk and only provide shade for parked cars in front of them and they don‘t have any kind of structure that provides shade like arcade which shows lower emphasis given to pedestrian by developments.

Figure 45. Absence of shade in roundabout (source; Senait Mohammed)

1.2.4.6. Pedestrian perception of comfort

According to Park (2008) pedestrian perception of comfort is measured by sense of security and buffering negative environmental effect.

1.2.3.6.1. Sense of security

According to Park (2008) pedestrian perception of comfort measured by Sense of security which affected by visibility at night, Visual Surveillance from Nearby Buildings and presence of others. In order to measure pedestrian perception four questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate sense of security (see table 13and fig. 46).

			almost always	usually	occasionally	rarely
feeling of being robbed	number of people	day	7	29	58	56
		night	14	91	41	4
feeling of getting help from people live/work in the nearby buildings if you mugged		day	11	34	58	47
		night	0	3	47	100
feeling of unsafe by presence of few people			47	51	22	30
feeling of unsafe by presence of more people			33	22	80	15

Table 13. Perception of pedestrians of being robbed and get help from surrounding as well as safety because of presence of other (source; questioners)

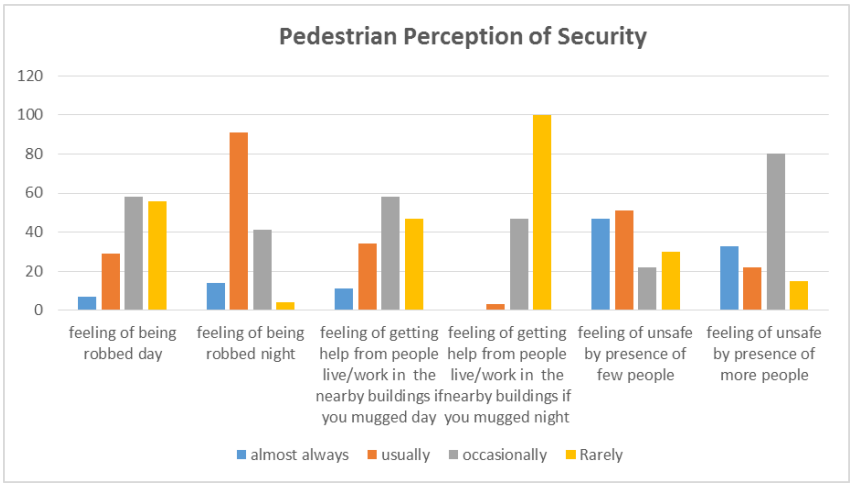


Figure 46. Perception of pedestrians of being robbed and get help from surrounding as well as safety because of presence of other (source; questioners)

From the data collected from the 150 questionaries‘ made to analyze the perception of people about the roundabout related to security, 34 % and 70 % of them feel they can be robbed and can get help from surrounding if they are exposed to crime at day time respectively . At night time 70% and 98% of them feel unsafe and being robbed/mugged and can‘t get any support from surrounding at night. In addition to that 65% and 64% of them feel unsafe if there are few and more people present at roundabout. In general the data show people fear of being robbed and not get support from people live or work in that area mainly at night and few people present.

1.2.3.6.2. Buffering negative environmental effect

According to Park (2008) pedestrian perception of comfort is one of measured by negative environmental effect which is affected by exposure to direct sunlight, noise, fume and vibration from street traffic. In order to measure pedestrian perception two questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate sense of security (see table 14 and fig. 47).

		almost always	usually	occasionally	rarely
feel uncomfortable because of too much direct sunlight	number of people	55	58	18	18
feel uncomfortable because of noise, fumes or vibration from street traffic		36	73	63	4

Table 14. Perception of pedestrians being uncomfortable because of exposure to negative environment (source; questioners)

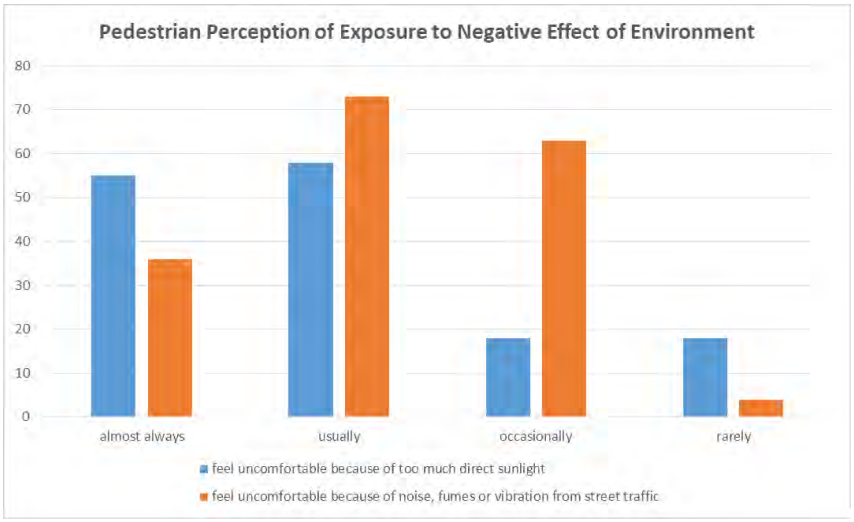


Figure 47. Perception of pedestrians being uncomfortable because of exposure to negative environment (source; questioners)

From the data collected from the 150 questionaries‘ made to analyze the perception of people about the roundabout related to the buffering and negative environment effect 75% of always exposed to direct sunlight and 72% are exposed to noise, fume released from cars. This data show the roundabout is exposed to direct sun, noise and fume because of absent of absence of buffer/ planting which protect those problems caused by vehicles.

1.2.5. Conviviality

According to Gallin (2001), conviviality can be measured by pedestrian flow rate.

1.2.5.1. Pedestrian flow rate

In order to analyze flow of people in the case study area pedestrian count is applied two times of a day at pick hour were most people go to and out of work. Based on the data collected the table below generated.

direction of flow		time interval						time interval					
		8:00-8:10	8:10-8:20	8:20-8:30	8:30-8:40	8:40-8:50	8:50-9:00	4:00-4:10	4:10-4:20	4:20-4:30	4:30-4:40	4:40-4:50	4:50-5:00
Kotebe-roundabout	number of pedestrian	343	300	304	290	224	174	240	256	263	300	286	314
Kotebe to roundabout		94	129	121	105	141	171	238	201	345	212	299	175
Shola to roundabout		73	84	69	108	92	93	125	102	101	113	107	143
Shola to roundabout		393	288	548	514	418	411	298	302	473	495	492	474
Bole to		229	201	236	243	259	220	179	195	201	256	323	319

roundabout													

Table 15. Number of pedestrian coming to roundabout at pick hour (source; pedestrian count made by Senait Mohammed)

direction of flow	from 8;00-9;00 am within 15 min				from 4;00-5;00 within 15 min			
	total	average	minimum	maximum	total	average	minimum	maximum
Kotebe-roundabout	1635	272	174	343	1659	277	240	314
Kotebe to roundabout	761	127	94	171	1470	245	175	345
shola to roundabout	519	87	69	108	691	115	101	143
Bole to roundabout	1388	231	201	259	1473	246	179	323
total	4303	717	538	881	5293	883	695	1125

Table 16. Total, average, minimum and maximum number of people coming to roundabout at pick hour (source; pedestrian count made by Senait Mohammed)

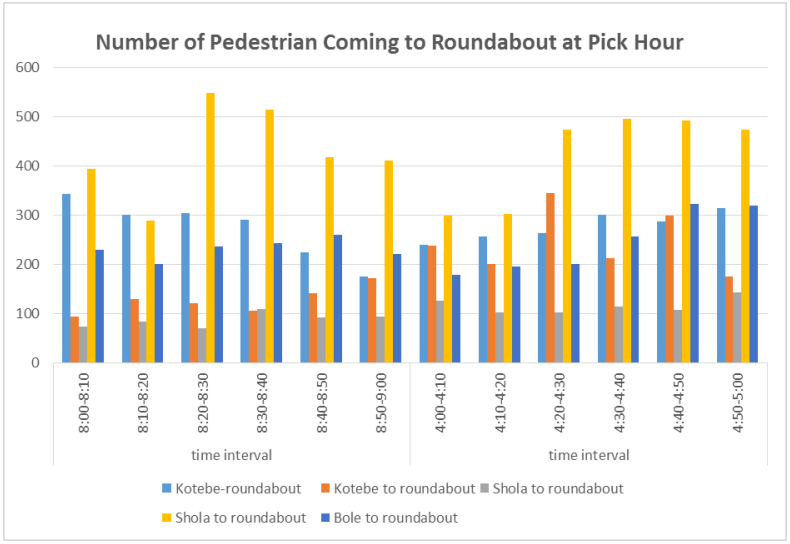


Figure 48. Number of pedestrians coming to roundabout at pick hour (source; pedestrian count made by Senait Mohammed)

In the case area there is an average of 1146 in morning and 1305 in afternoon people comes mainly for transport usage. Those people largely flow from Shola and Megenagna direction (see table 15 &16). But those people use roundabout just for passing through to arrive other places not to spent there and interact with surrounding environment as well as other people because of lack of pedestrian facility, attractive features, variety of function and large number people, low traffic volume and speed which encourage people to stay for a longer period of time. The absence of those facilities has a negative impact on perception of people about roundabouts in respect to safety, security, comfort, aesthetics and other important needs of people as well as their existence. Around the roundabout there are different mixes of user other than pedestrians like street vendors, shoe shine boy and mobile street sellers. They are illegal but their presence has positive and negative side because positively they provide

service for people but in negative side they don‘t have proper arrangement and occupy the space provide for pedestrian this will reduce clear width of pedestrians which led to overcrowded sidewalk. This usually occurs at the time interval 11pm to 8am. As the same time their presence somewhat important to enhance the security of that area it they are provided proper space and well design.

1.2.6. Coexistence

1.2.6.1. Safety

According to Maghelal (2010) and Krambeck (2006) number of accident occur in the intersection and crossing safety which is related to type of crossing, presence of sign, existence of refuge island & curb extension and raised pedestrian are important to safety related to coexistence.

The roundabout has two zebra crossings with refuge island and defined by raised pedestrian sidewalk. The crossings are less visible and don‘t have pedestrian sign and curb cut which makes it inaccessible and unsafe for people.

Accident occur at Diaspora round about	
From 1/11/2004 to 30/10/2005	0
From 1/11/2005 to 30/10/2006	1- day; 5/11/2005 time: 2141 day: Friday - cause: don‘t let pedestrian to cross at crossing - profile of driver: male & 60 yr old ownership- private - type of car: Toyota code:2 - place of accident: kebele 13/14, marathon building - profile of road: divided by island, has straight alignment, having an intersection, covered with asphalt, dry - condition of environment: lighting-at night with streetlight & good climate - movement of car: straight - pedestrian profile: female & 30yr old, healthy - type of accident: death
	2- period: September 26/06 time: 0736 day: Sunday - cause: don‘t let pedestrian to cross at crossing - profile of driver: male, 48yr old & has diploma - Ownership: employer type of car: land cruser code-35-764 ed location of accident: kebele 13/14,Maraton bldg.

	- profile of road: divided by island, straight alignment, has intersection, paved by asphalt, wet - condition of environment: morning sun & good - movement of car: straight - pedestrian profile- male, 45yr old, work as guard and healthy movement of pedestrian-right-left type of accident: hard

Table 17. Accident profile of roundabout (source: yeka sub city police station)

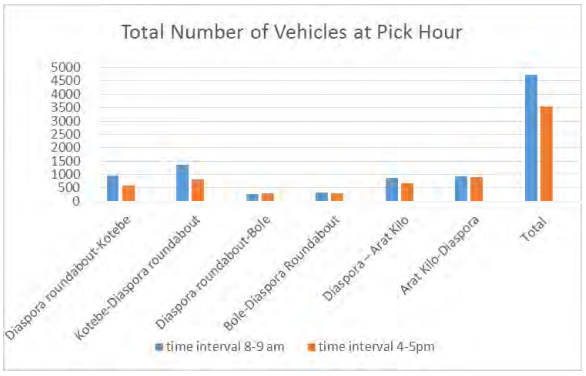
In general from the 2yr data collected accident rate increase from 0 to 2% (see table 17). There is only two accident occur on the elder ones at night time in normal environmental condition near marathon building. The main cause of accident is not letting the pedestrian cross at crossings which led to death and hard health condition of pedestrian. This shows low level of safety problem happened on pedestrians.

1.2.6.2. Traffic volume

According to Maghelal (2010) and Park (2008), coexistence can be measured by using average traffic volume, average speed and the presence of traffic calming elements which are important to reduce traffic speed.

direction of flow	time interval		total number of vehicle per day
	8-9 am	4-5pm	
Diaspora roundabout-Kotebe	942	574	7713
Kotebe-Diaspora roundabout	1366	816	9385
Diaspora roundabout-Bole	272	288	2647
Bole-Diaspora Roundabout	336	285	1796
Diaspora – Arat Kilo	866	671	7223
Arat Kilo-Diaspora	936	902	8787
Total	4718	3536	37551

Table 18. Number of vehicle coming to the roundabout (source; vehicle count made by Senait Mohammed)



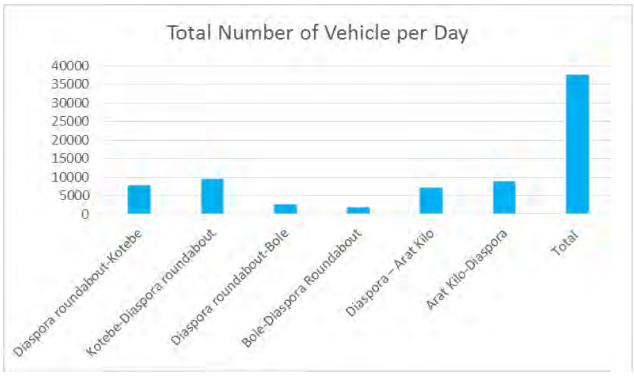


Figure 49. Number of vehicle coming to the roundabout (source; vehicle count made by Senait Mohammed)

The above data on the table 18 shows many cars come to roundabout especially from Kotebe and Arat kilo direction which is higher than pedestrian and also less than 45000 number of car which multilane roundabout can handle per day. This makes it sufficient for movement of car.

1.2.6.3. Speed of vehicle

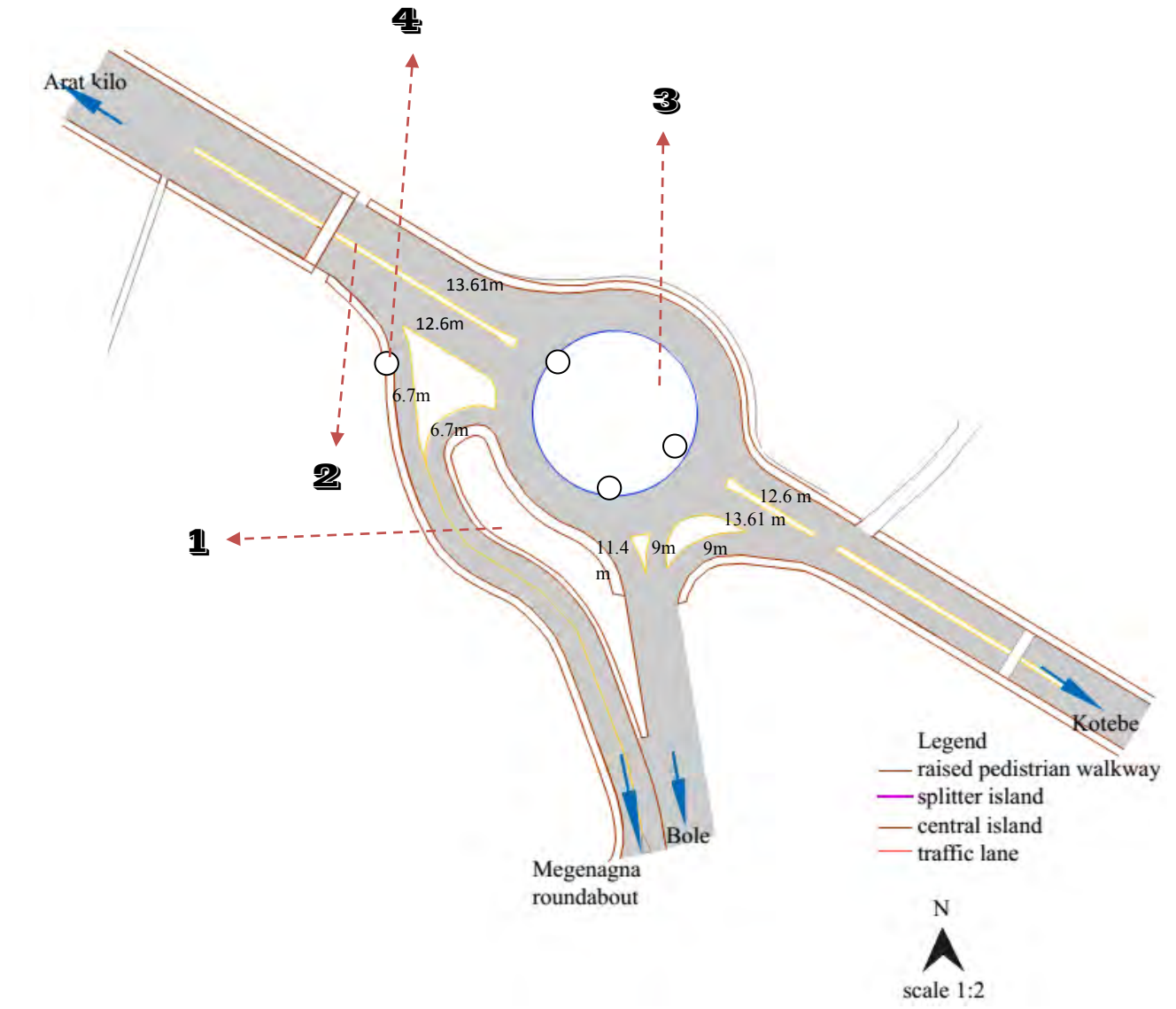
direction	average entry speed (Km/hr)	exit speed (Km/hr)	circulating speed (km/hr)
kotebe to shola	20	21	20
shola to kotebe	34	30	37
bole-shola	17	25	25
shola-bole	32	35	29
kotebe-bole	24	43	24
megenagna-shola	22	30	28
Average speed	25	31	27

Table 19. Speed of vehicle on the roundabout (source; measurement made using radar by federal police head officers)

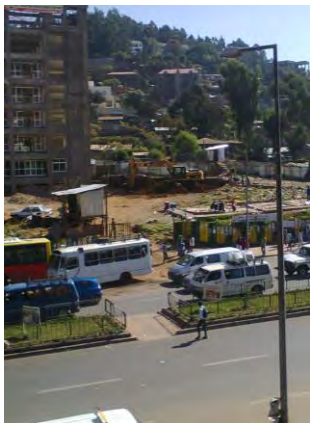
From the sample measure taken using radar to evaluate the existing speed of car inside the roundabout. Based on measurement most of cars move at lower speed than the allowed speed in multi-lane which is 25-30mph or 40- 50 km/hr entry speed. The car come from shola enter at highest speed and also were accident occur with respect to the other lanes.

1.2.6.4. Traffic calming elements

There are different traffic calming element incorporated in the roundabout including 0.3m raised splitter Island, Central Island, lower entry and exit width, 0.3m raised pedestrian walkways and slow signs (see fig. 50). The presence of traffic calming elements is positive impact on slowing vehicular speed.



1 Splitter Island



2 Splitter Island

3 central islands

4 slow down

Figure 50. Traffic calming element (source; Addis Ababa structural road network map edited based on survey and photo taken by; Senait Mohammed, 2006)

Central island- has a circular shape with a diameter of 60m and height of 0.3m. It has no enhancement feature serve both an aesthetic purpose and provide conspicuity of roundabout. It is not painted with white color. This encourages high speed movement of vehicle.

Yield sign- which give information about the presence of roundabout and need of slowing down for driver.

Entry Alignment- alignment of entry of bole road is a kind of offset alignment to the left of center which allow increasing of deflection and can accommodate large track with small inscribed circle diameter-allows for large entry radius while maintaining deflection and speed control and reduce impact of right side of roadway but it increase exit radius or reduce control of exit speed and acceleration through crosswalk area and create great impact to left side of roadway. The alignment of entry of kotebe and Shola road is the same which is through center of roundabout which reduce amount of alignment change along approach roadway to keep impacts more localized to intersection and allow some exit curvature to encourage drivers to maintain slower speed through exit but it also increased exit radius control of exit speed trough crosswalk area and require larger inscribed circle diameter to provide same level of speed control.

Splitter island- it provides refuge for pedestrians, control speed, guide traffic, separate traffic stream and deter wrong way movement. It also used as a place for mounting signs. If it‘s long it can help reduce confusion for entering motorists. It also has desirable size which is 13m length and 1.8 widths. But it doesn‘t have any detectable surface for disabled ones. This makes it inaccessible.

1.2.6.5. Motorized network

According to park (2008) average number of traffic lanes is one of measurement of coexistence of motorized network.

Form the site observation the Diaspora roundabout has 19 lanes which include 10 exit and 9 entry lane as well as two circulatory lane. From those lanes 14 of them are found on the path led to kotebe and Arat kilo were larger size of traffic volume generated. But the other two paths led to bole and Megenagna has only one entry lane and also carry low traffic volume less than 1000. This shows as number of lane increase the traffic volume also increased as well as area used for road also will increase.

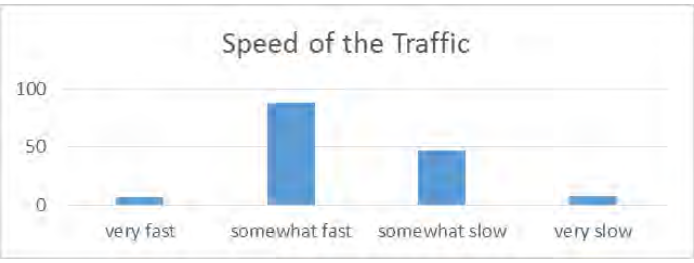
1.2.6.6. Sense of safety

According to Park (2008) pedestrian perception of coexistence is measured by Sense of safety affected by traffic speed and also facilities provided at crossing and also sidewalk affected by traffic volume. In order to measure pedestrian perception eight questions asked which is adopted from Park.

In the questionnaires 150 different types of people participate to evaluate sense of security (see table 20 and fig. 51-52).

speed of the traffic		very fast	somewhat fast	somewhat slow	very slow
number of people		7	88	47	8
		almost always	usually	occasionally	rarely
car driver let pedestrian to cross at crosswalk	number of people	14	36	66	44
feeling of unsafe crossing at crosswalk		29	62	36	23
feeling of safety because of presence of more crossing and pedestrian sign		44	69	25	12
		very dangerous	slightly dangerous	relatively safe	very safe
feeling of crossing at crosswalk	number of people	44	77	25	4
		almost always	usually	occasionally	rarely
feeling of danger on sidewalk because of car entering driveway		14	58	36	42
feeling of fast moving car lose control and harm		47	62	30	11
feeling of safety by presence of barrier b/n sidewalk and traffic lane		51	62	25	12

Table 20. Perception of safety of pedestrians (source; questioners)



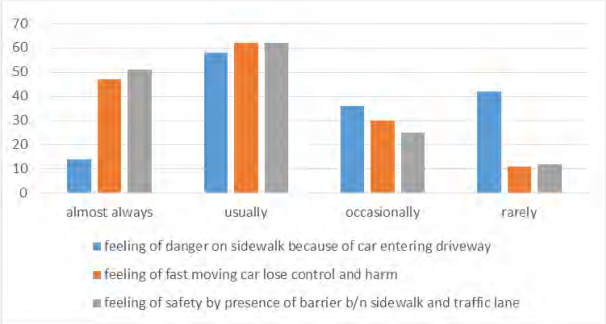


Figure 51. Perception of pedestrians with presents speed of the traffic and while walk on sidewalk (source; questioners)

Figure 52. Perception of pedestrians while they cross at crossing (source; questioners)

In general the above data shows most of pedestrian feel the vehicular speed in the diaspora roundabout is fast and they fear those vehicle will lose control and harm them as they move inside and enter to roundabout. Because of that they feel unsafe to use pedestrian crosswalks and sidewalks.

1.2.7. Commitment

According to krambeck (2006) existence/enforcement of pedestrian safety laws/regulations and funding devoted to pedestrian planning are measurements for commitment. **ex**istence/enforcement of pedestrian safety laws/regulations.

1.2.7.1 Funding devoted for pedestrians planning

In Addis Ababa government fund for road and other facility in general but there is no secluded fund for maintenance of roundabout. In general the government fund as city level as shown in table 21

budget fund for project and its implementation in 2005				
project name	length of project	amount of budget fund for project	amount of fund used	implementation
maintenance of asphalt road	13630	21670347	18392905	228
maintenance of drainage	99039	4088030	8103571	198
maintenance of gravel roads	20159	4730075	6021202	127
buildup and maintenance of road safety traffic operation	289300	12562305	24417643	603
maintenance of pedestrian walkways	6849	3759896	7012336	187
maintenance of bridge		3921350		
total		50732003	63947657	126
budget fund for project and its implementation in 2006				

project name	length of project	amount of budget fund for project	amount of fund used	implementation
maintenance of asphalt road	29265	26610070	25028405	94
maintenance of drainage	137073	6969597	8808872	126
maintenance of gravel roads	6901	4371000	1683879	39
buildup and maintenance of road safety traffic operation	12865.963	12718741	19875775	156
maintenance of pedestrian walkways	5220	3418030	1461217	43
maintenance of bridge	2	1284832		
total		55372270	56858149	103

Table 21. Amount of fund spent on road maintenance (source: AACRA)

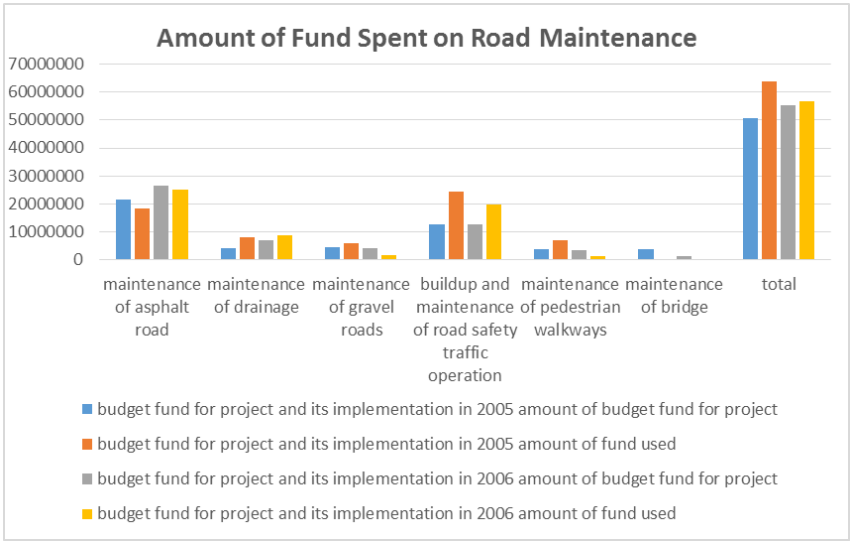


Table 22. Amount of fund spent on road maintenance (source: AACRA)

From above table show low consideration to because most of money funded project is for maintenance of large area of road network which is 422128 m and 6849 for pedestrian. In order to maintain pedestrian only 7 % of 50732003 funded and other 93% is funded for road maintenance and from those fund only 1.86% of it used for maintenance of pedestrian and 112% for road maintenance.. In 2006 also fund made for 13039204 m length of road maintenance and 5220m length of pedestrian walkway. In order to maintain those only 6.17% of the total 55372270 is funded for but other 93.83 % funded for road and only 42.7% funded used for maintenance of pedestrian and 106% spent on the road. This means for road maintenance extra money also funded. In general it shows the government gives more emphasis to road maintenance than pedestrian which create a car oriented environment.

1.2.7.2. Pedestrian safety laws/regulations

For pedestrian- all pedestrian have to walk on the left side which is important to see the car come in front of him/her, walk only on road side having sidewalk and be careful of car entering to driveway; cross only at crossings and apply four global rules including stop, see left and right, listen and think before you cross using your eye, ears before you use your feet and respect traffic signs and if pedestrian walk on ring road only use bridge. Crossing at the roundabout is also not allowed because it‘s dangerous and all pedestrian must cross all the paths connected which makes it is difficult to know from what direction the vehicle comes

Driver- must let pedestrian especially the disabled ones cross at crossing and respect signs and road paintings, drive based on speed limit of the area.

In general even though there is a regulation mostly they are not respected by pedestrian and driver because pedestrian movement always affected by quality of surface material, traffic volume and speed, crowdedness, presence of obstacles, car entering driveway/parking area, accessibility and visibility of crossings. In order to avoid those people don‘t respect the regulation. And also because of good carrying capacity and surface quality with low visibility of crossing and absence of pedestrian signs drivers drive and don‘t let pedestrian to cross.

1.3. Major findings

Connectivity

Diaspora roundabout lack connectivity with surrounding because of lack of sidewalk continuity, presence of permanent and temporary obstacles, inappropriate location and few opportunities of crossing, long crosswalk length and travel distance, lack of balanced connection with surrounding and presence of large block surrounding the roundabout. But it has a variety of choice of access to public transportation within short walking distance and it is connected to different roundabout developed within the city which makes it highly connected with other part of city even though the location of transport facilities reduces visual connection between vehicle and pedestrians as well as the operation of roundabout. The pedestrian also feel it is not well connected because they feel uncomfortable on existing pedestrian facility because of it‘s over crowdedness as well as car entering driveway.

Conspicuous

Diaspora roundabout has weak enclosure because of presence of low rise buildings, vacant space and larger space of parking as well as wide road network. So there ratio is not proportional and also not human scaled. It‘s also not legible because it doesn‘t provide signs for the pedestrians these led to confusion and inappropriate use of space. Most of the pedestrian don‘t have any attractive and interesting to see because there are no landscaping elements on roundabout. These make the roundabout less conspicuous.

Convenience

The functions surrounding the roundabout including it is mainly dominated by transport stations, car parking and road network because of the presence of terminals and high emphasis given to cars by the new developments and also design of roundabout which makes the roundabout car dominated space. It has land use mix value of 0.6 which shows lack of variety of function. The pedestrian sidewalk has less clear sidewalk which couldn‘t accommodate pedestrian volume, poor surface quality and less cleanness because of the presence of temporary and permanent obstacles, lack of maintenance, presence of high traffic volume and not well maintained and managed drainage and waste disposal sites. It is also not easy for blind and disabled ones because it lacks blind and disabled facilities. Pedestrians also less convenient because of difficulty in crossing at crosswalk and the longer time it take as well as absence of variety of function. This makes the roundabout less covenant.

Comfort

Diaspora roundabout is characterized by of absence of amenities including benches, shades, buffer, pedestrian light and signs, presence of few windows and large area with longer fence facing towards the roundabout, less security problem and over crowdedness of sidewalk which exposed the area to crime, sunlight, wind, rain, pollution, and accident. The pedestrian also feel uncomfortable because they fear being robbed and couldn‘t get any help by others as well as feel unsafe whether there is less or more people appear on roundabout. This makes the roundabout uncomfortable.

Conviviality

In Diaspora roundabout an average of 1146 people in morning and 1305 in afternoon people coming to roundabout this shows there is a high flow of pedestrians at pick hour this makes the roundabout a public space but due to large space given to vehicular traffic and the fast movement of vehicles people tend to linger along the edges and do not interact with other users as much. Most of pedestrians mainly flow to the roundabout in order to get transportation service and use it as pass through because of the above written problems. This shows the roundabout is less convivial.

Coexistence

Diaspora roundabout is multilane roundabout which accommodate 45000 vehicles per day. In the present condition it accommodates 37551 vehicle/day and at pick hour in morning 4718 and in afternoon 3536/hr which makes it efficient roundabout for vehicles traffic flow and high speed movement even though there are different traffic calming element introduced including splitter island, central island, slow down sign, raised sidewalks. There is less rate of pedestrian vehicular accident even though there are a higher number of vehicular lanes which generate large number of traffic with fast speed vehicular movement by increase crossing length. The pedestrian also feel unsafe and dangerous at crossing and walk on sidewalk because of fast moving traffic and feel safe in place were many signs, crossing and barriers placed. This led to less coexistence of pedestrian.

Commitment

In Addis Ababa the government only involve in funding for the maintenance and construction for pedestrian. But the fund assigned for pedestrian is very low when it is compared to fund made for road network. These show lower emphasis given for provision of

place for people. The government also provides laws and regulations that restrict people not to come to the roundabout these developed negative perception of people about roundabout. Other laws and regulations related to sidewalk and crossing usage are not implemented by people because of the absence of pedestrian friendly environment.

Chapter 5. Conclusion and Recommendation

5.1. Conclusion

In general Diaspora roundabout is one of modern type of roundabout found in Addis Ababa designed based on AACRA manual to handle the increasing demand of vehicular traffic in Addis Ababa. It is a junction found within major sub center of city were four path meet that link city with other region as well major sub center with the other part of city and effectively function for movement of cars not for pedestrians because it is characterized by lack of mixity of function; less dense development; weak enclosure; lack of physical and visual connection with surrounding; poor quality, well integrated and sufficient pedestrian facilities; lack of attractive and interesting thing to see; large blocks and parking space; absence of blind and disabled facility; sound and air pollution; high traffic volume with fast speed movement; and high pedestrian flow. The government also gives less emphasis for pedestrian facility and just adopted crossings, splitter Island, signs and other traffic calming facilities as the only way of enhancing safety and less delay for pedestrians and set rules and regulation that discourage the presence of pedestrians inside the roundabout. Because of the above reasons most of pedestrians has negative perception about roundabout and feel the roundabout is not well connected, covenant, conspicuous and comfortable for their movement. This makes the roundabout car dominated junction and unfit to basic need of people.

5.2. Recommendations

This research investigate different problems of the case study area from analysis in order to alleviate those problems these thesis recommend the shared space planning approach developed based on common agreement among motorists, cyclists and pedestrians concerning the widest possible elimination of traffic controls, light signals and signing. In order to achieve these following techniques are recommended.

Integrated work of traffic engineering with urban design- in case area the design of roundabout carried out by traffic engineers work at AACRA only considering demand of vehicular traffic movement not the social aspect. But the roundabout as a node must act as a social space in addition to its function for movement.

Rich urban landscape- in diaspora roundabout vehicle move at fast speed and also pollute the environment as well pedestrians expose to negative environmental effect and few part of roundabout is affected by flooding because of lack of management system so introducing landscape reduces vehicular speed, enhance the attractiveness of roundabout, protect flooding and also reduce negative environmental impact of vehicles on the surrounding environment as well as the pedestrians**.**

Mixed use dense development – the roundabout lacks mixity of function because of that pedestrian can‘t get access to different function at a time and it is also less dense these because of the presence of vacant space, low rise development, less development, large parking area and road network and large terminal. This makes it car dominated environment to make roundabout pedestrian friendly encouraging mixed use dense development is important because it provides variety of functions within shorter distance and also to use the land efficiently.

Introducing blind and disabled pedestrian facilities- in diaspora roundabout there is no emphasis is given to blind and disable people because of that those people fear as they come to roundabout. In order to attract those people and get access to any facilities special treatment must be made like textural cue, ramp, curb ramp and detectable warming surface. This will guide them to appropriate place.

Well designed and integrate pedestrian facility- the case study area lack pedestrian facilities like benches, street light, shade, garbage can, public toilet, information desk, pedestrian sign, bus station, efficient sidewalk and crossing. Because of that pedestrians fear for their safety and security, exposed to different obstacles and negative environmental effect

like harsh sun, wind and bad odor. To solve the problem sidewalk continuity by removing temporary and permanent obstacles and integrating driveway with sidewalk and also proper sidewalk zoning with appropriate size is important which include edge zone, buffer zone, through way and frontage zone as well as maintenance of existing facility.

Enhance visibility of pedestrians by vehicles and surrounding – pedestrians are not much visible by driver because of inappropriate placement of stations, presence of obstacles and many traffic lanes and they also don‘t have visual contact with surrounding. These make pedestrians to feel unsafe, uncomfortable and unsecure when they cross and walk on sidewalk. In order to solve the problem and enhance visibility development with more windows facing roundabout, encourage indoor and outdoor activity, street activity, proper allocation of facilities and adoption of curb extension is appropriate.

Introduction of attractive and interesting features - within the roundabout there is no interesting or attractive thing to see like greenery, fountains, sculptures, landmarks and sitting areas. Introducing those elements into roundabout is important to make site attractive, enhance interaction of pedestrians with roundabout and also reduce traffic speed.

Medium and small size development- the presence of larger blocks surrounding the roundabout it makes it inaccessible to improve accessibility and walkability compact development of block must be encourage.

Quality public space – the case area lack high standard pedestrians facility with proper pavement material, size, location and elements which serve as social space. In order to attract pedestrians and allow them to stay for longer period in addition to sidewalk and crossing other spaces must be provided like public square and waiting areas which provide space for sitting, playing and meet others especially for children‘s and older ones.

Integrating the structural planning- the existing roundabout not developed as structural plan of the city so integrating them is important to implement the strategy of the city.

Use of shared surfaces - demarcation is absent and pedestrians and vehicles share the same surface… in the absence of a formal carriageway, the intention is that motorists entering the area will tend to drive more cautiously and negotiate the right of way with pedestrians on a more conciliatory level.

Chapter 6. Design recommendation

6.1. Introduction

This section of the research shows different principles, programs; concepts and design strategies developed to tackle problems of diaspora roundabout described in general findings from the seven main human needs perspective by taking in to consideration important concepts from international case studies and also literature review.

6.2. Urban Design Principles

- Well integrate and connected roundabout node
- Mixity of function
- Human scale and dense development
- Legibility
- Quality public realm
- increase safety and security
- economic feasible development

6.3. Planning Program

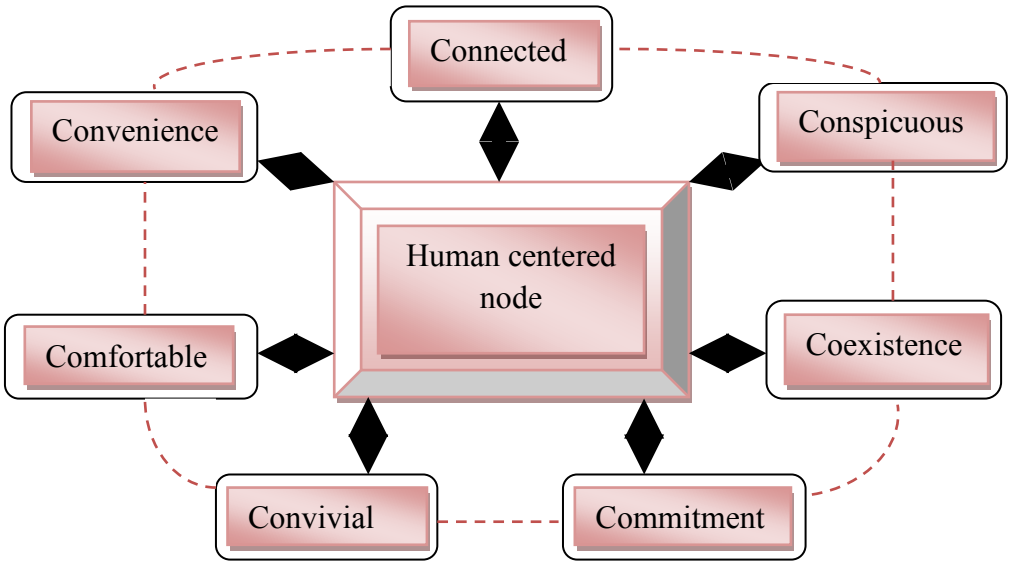
1. Integrate roundabout with surrounding environment and other nodes
    - Enhance sidewalk continuity and connectivity with surrounding
    - Increase number of intersection and paths connected to roundabout
    - Increasing the number of crosswalks at appropriate location by minimizing it‘s crossing length
    - Small block development
    - Support public transport
2. Human scale and dense development
    - Encourage high rise dense development on lower dense environment as well as on unused and large boarder up parking areas

3. enhance legibility
    - provision of pedestrian scale signs
4. Mixity of function
    - Provision of variety of functions at one place
    - integrate indoor and outdoor activity
5. Quality public realm
    - Development of visual attractiveness and variety of features like fountain, sculptures, landmarks, greenery …
    - provision of blind and disabled facilities
    - well maintained, paved, clean and efficient walkways with absence of obstacles
    - Provision of quality pedestrian facilities including shed, benches, street light, toilet...
6. increase safety and security
    - increase number of window facing to the roundabout
    - street side development on unused and boarder up parking areas
    - enhance ground floor function
    - provision of pedestrian scale streetlight
    - provision of traffic calming techniques like buffer, sign, curb extension at crossing
    - provision of place for street sellers
7. economic feasible development
    - pedestrian dominated development
    - large fund for pedestrian facilities, development of design standards and regulation that give emphasis to pedestrians

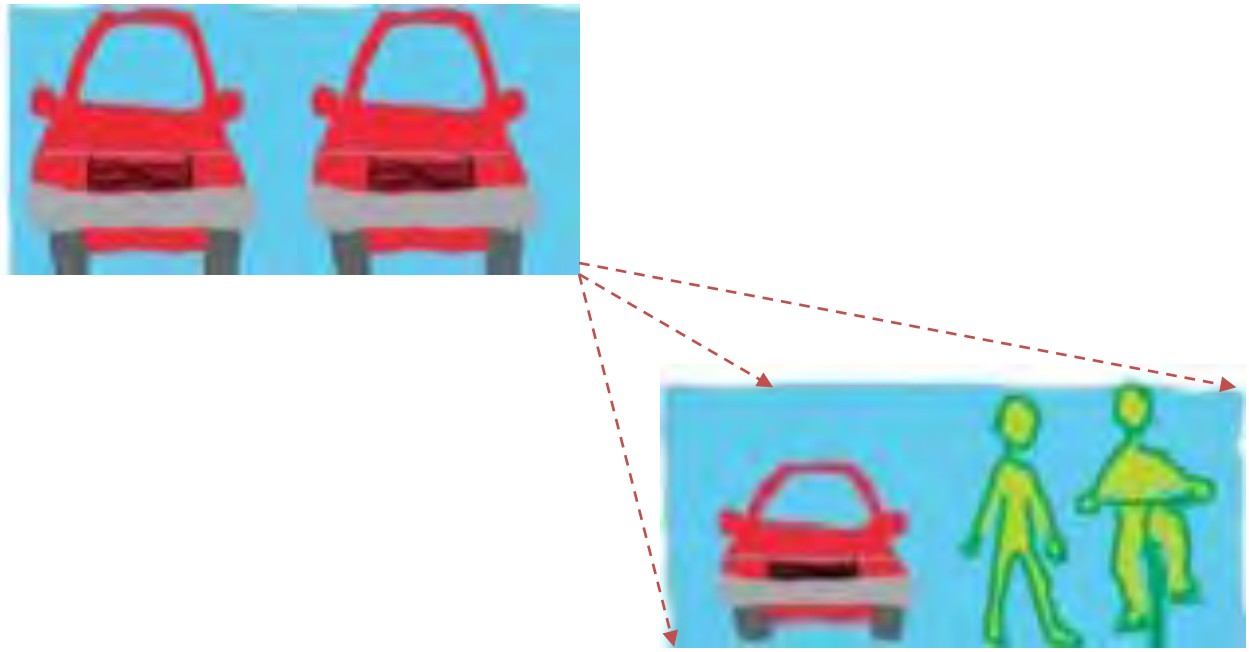
6.4. Urban Design Concept Diagrams

- Human centered
- Imageable

Node



The major concept is to replace the car dominated space into public place were balance share of vehicle and peoples share.



6.5. Design strategy

- Development of visual attractiveness and variety of features through integration of green development by planting shrubs and trees with the existing roundabout in the place between traffic lane and pedestrian lane, on vacant spaces, place affected by flood as well as within central island as well as the development of fountain and landmark.

Figure 53. Green development with fountain and landmarks

- Enhance Sidewalk continuity through integrating sidewalks with driveway on place were sidewalk continuity lacks because of the presence of driveways as well as removing temporary and permanent obstacles found on sidewalk through sidewalk zoning

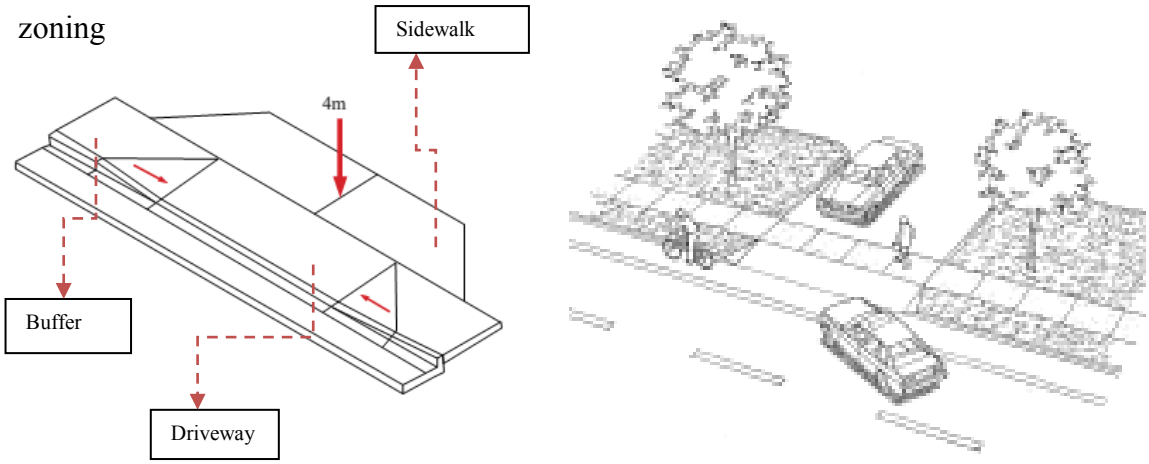
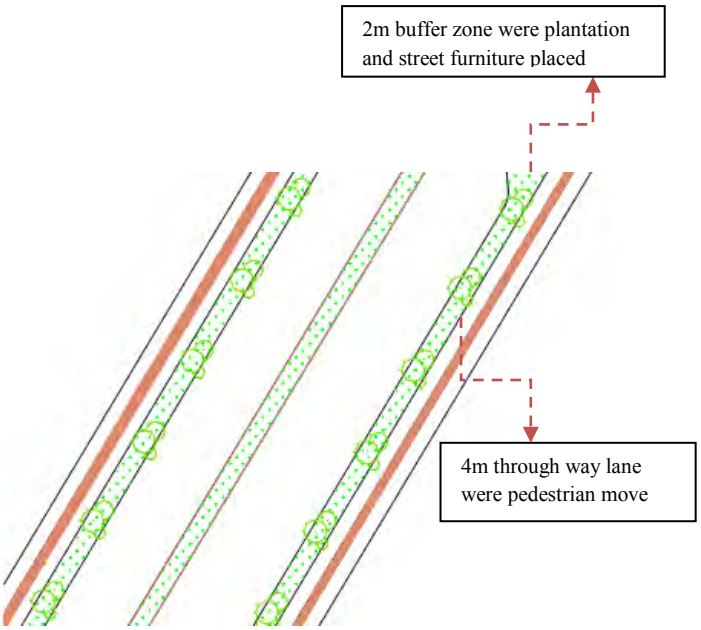


Figure 54. Driveway with sidewalk behind



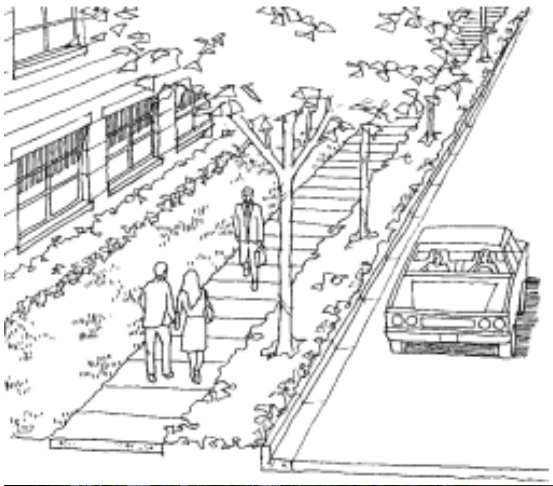


Figure 55. Sidewalk zoning

- Appropriate location of crossing by placing them near to roundabout and integrate them with surrounding development, increasing crossing opportunity, increase their visibility by providing additional crossing on the traffic lane with no crossings, reduce crossing width of existing crossing through curb extension and raise the height at level of sidewalk and use special surface treatment.

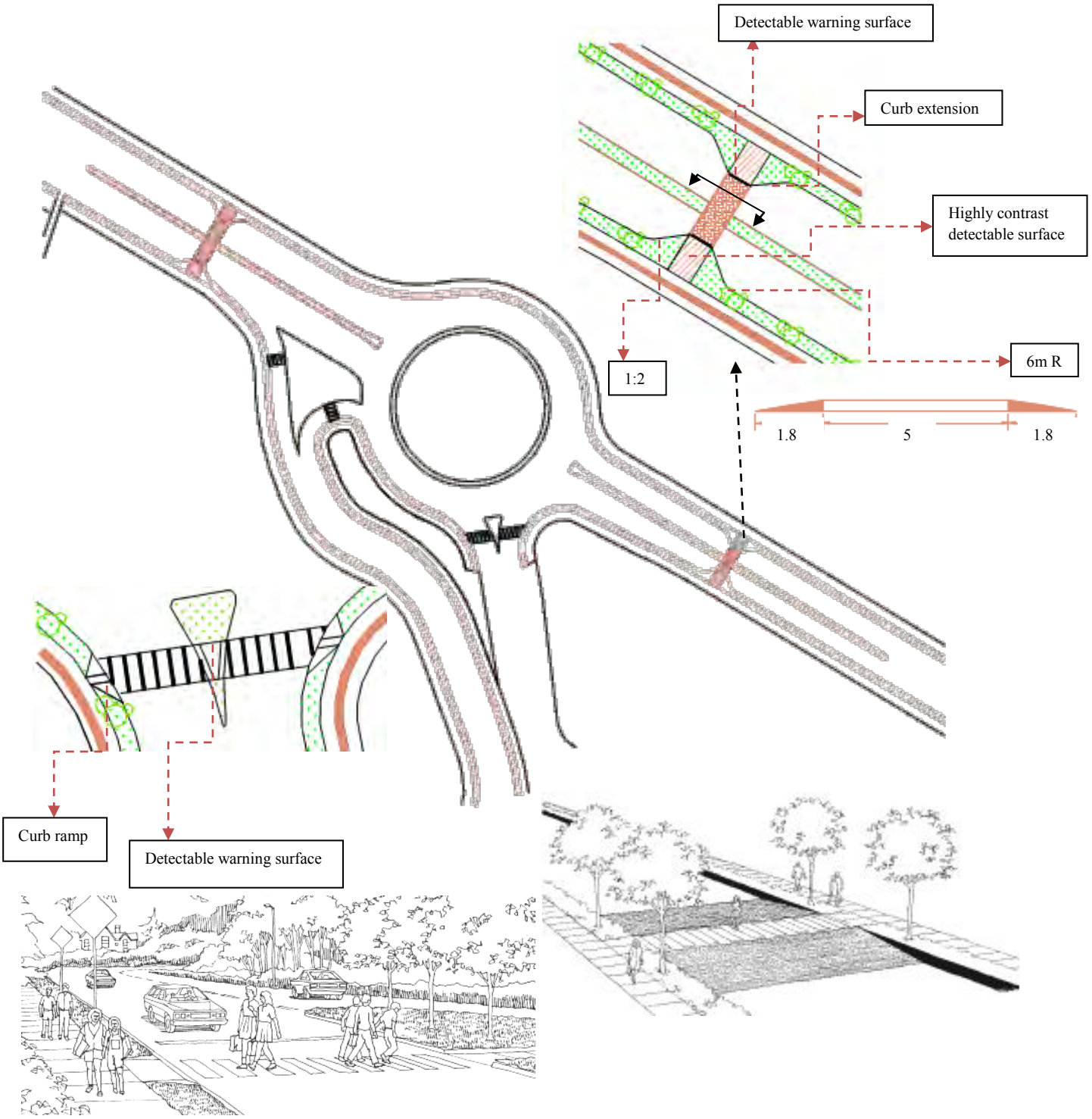
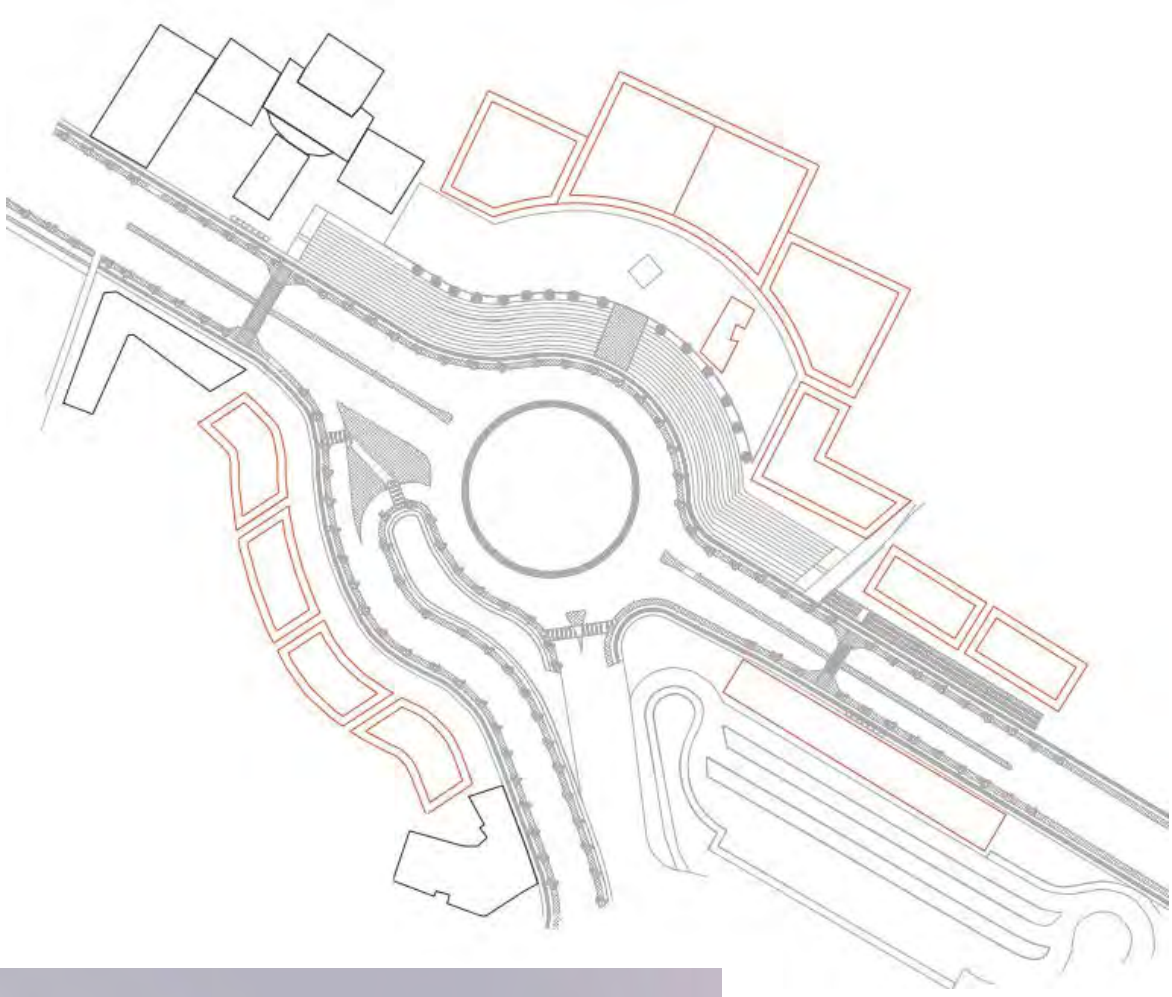


Figure 56. Raised crossing with curb extension and zebra crossing

- increase the density of the site by the adoption of short and medium size block/ buildings having not more than 50m length on the place where poor condition of building exist and large space occupied by parking as well as on the vacant spaces.



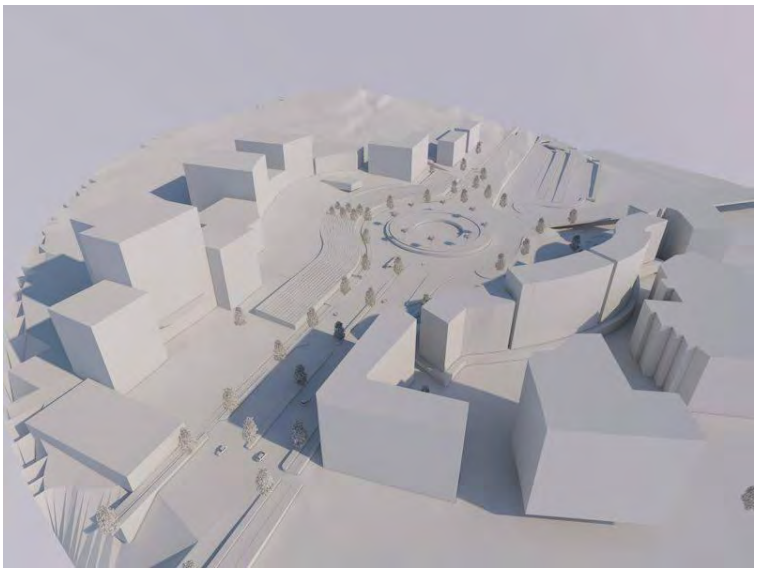
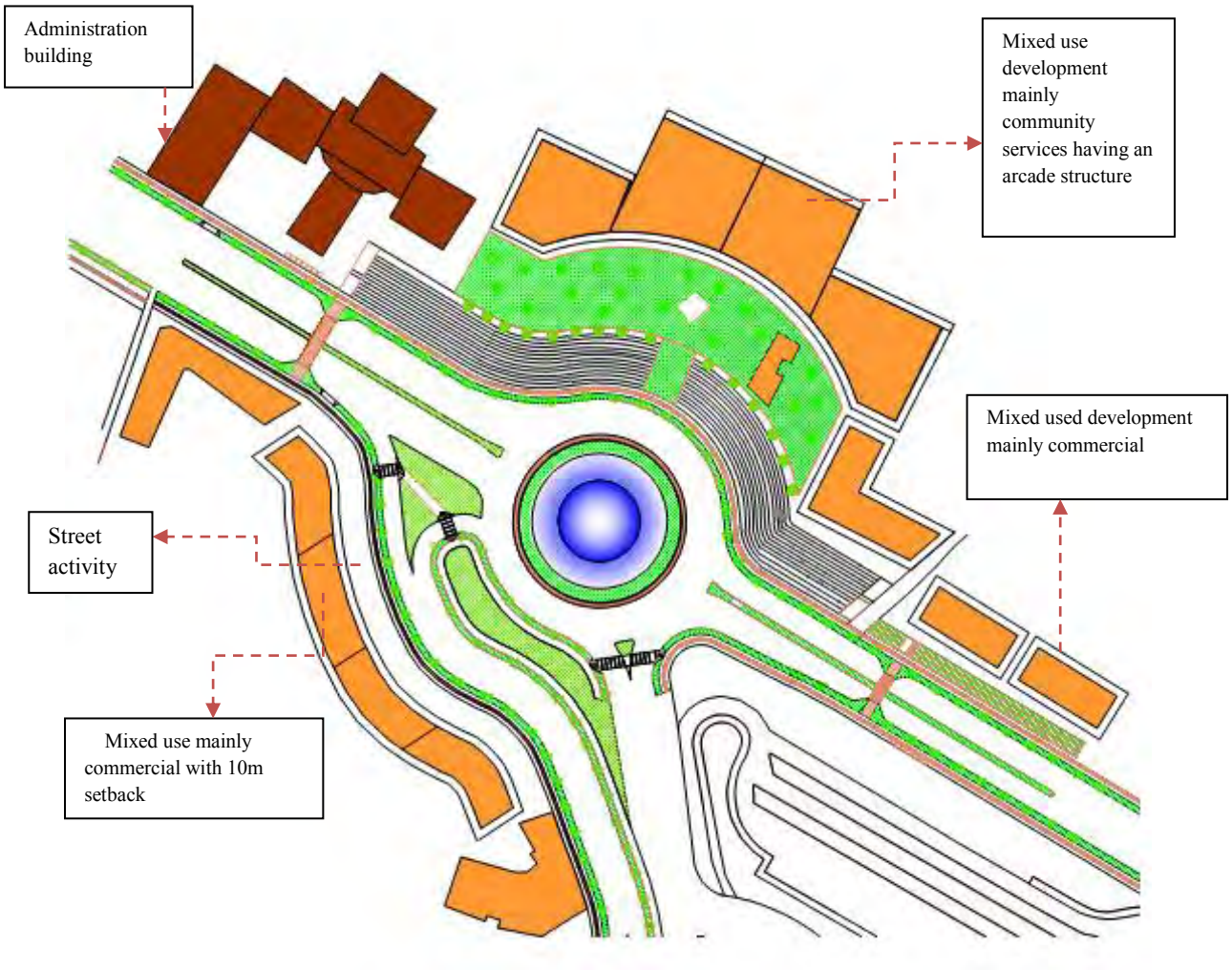


Figure 57. Small and medium size building/block development

- Mixed use development by providing of different facilities at one place and integrating indoor and outdoor activity as well as street trade activity



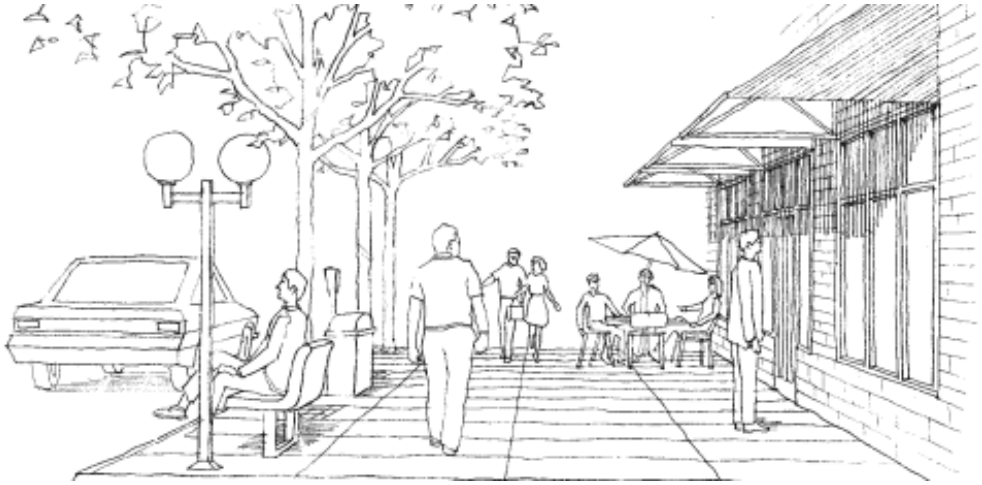


Figure 58. Mixed use development

- increase it enclosure by introducing dense development on vacant space as well as on place were poor condition development exist as well as planting trees, provision of squares and appropriate setback that give strong definition for roundabout

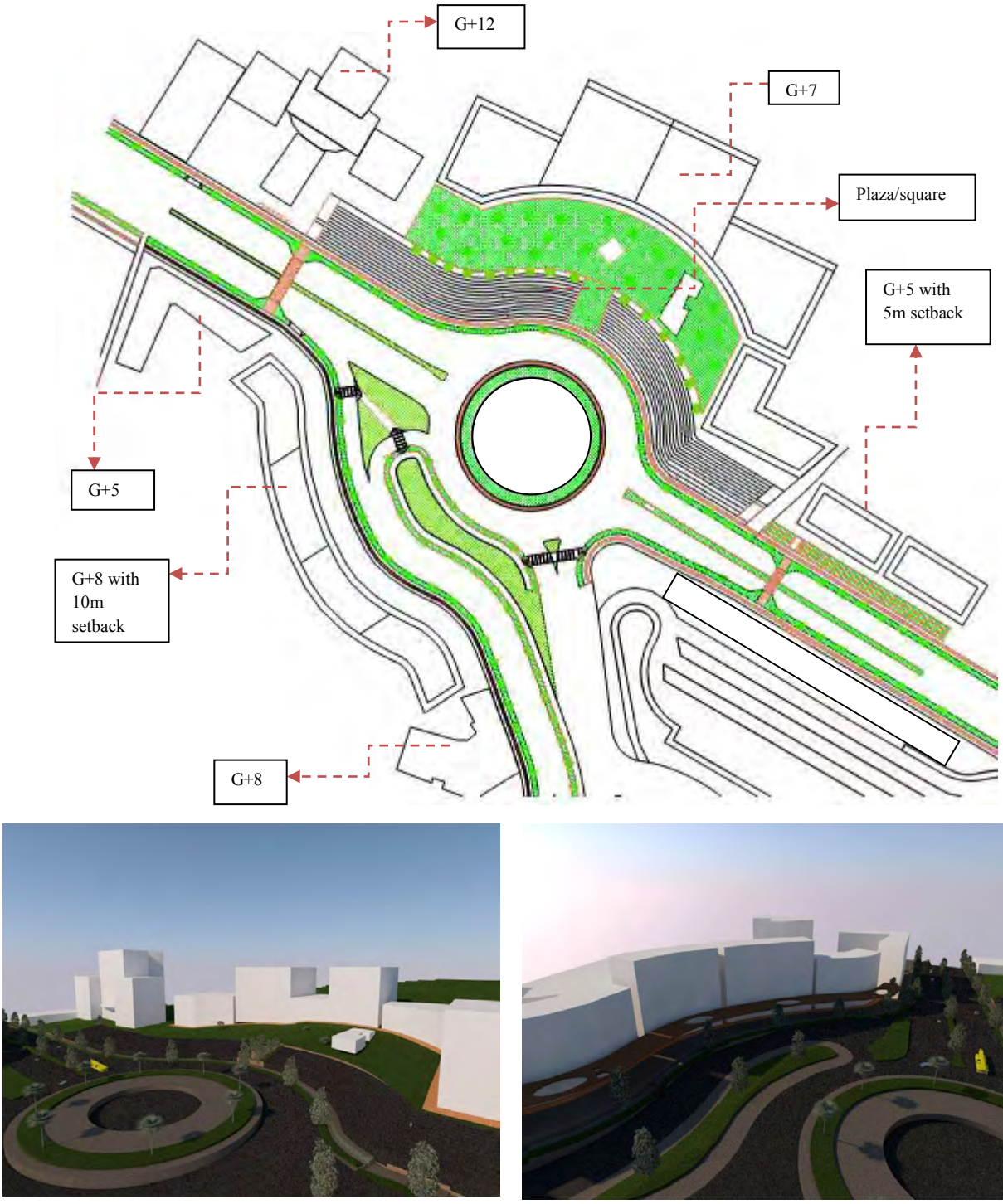


Figure 59. Height regulation, setback and tree coverage

- provision of pedestrian scale signs including directional sign, pedestrian crossing sign to enhance legibility of place

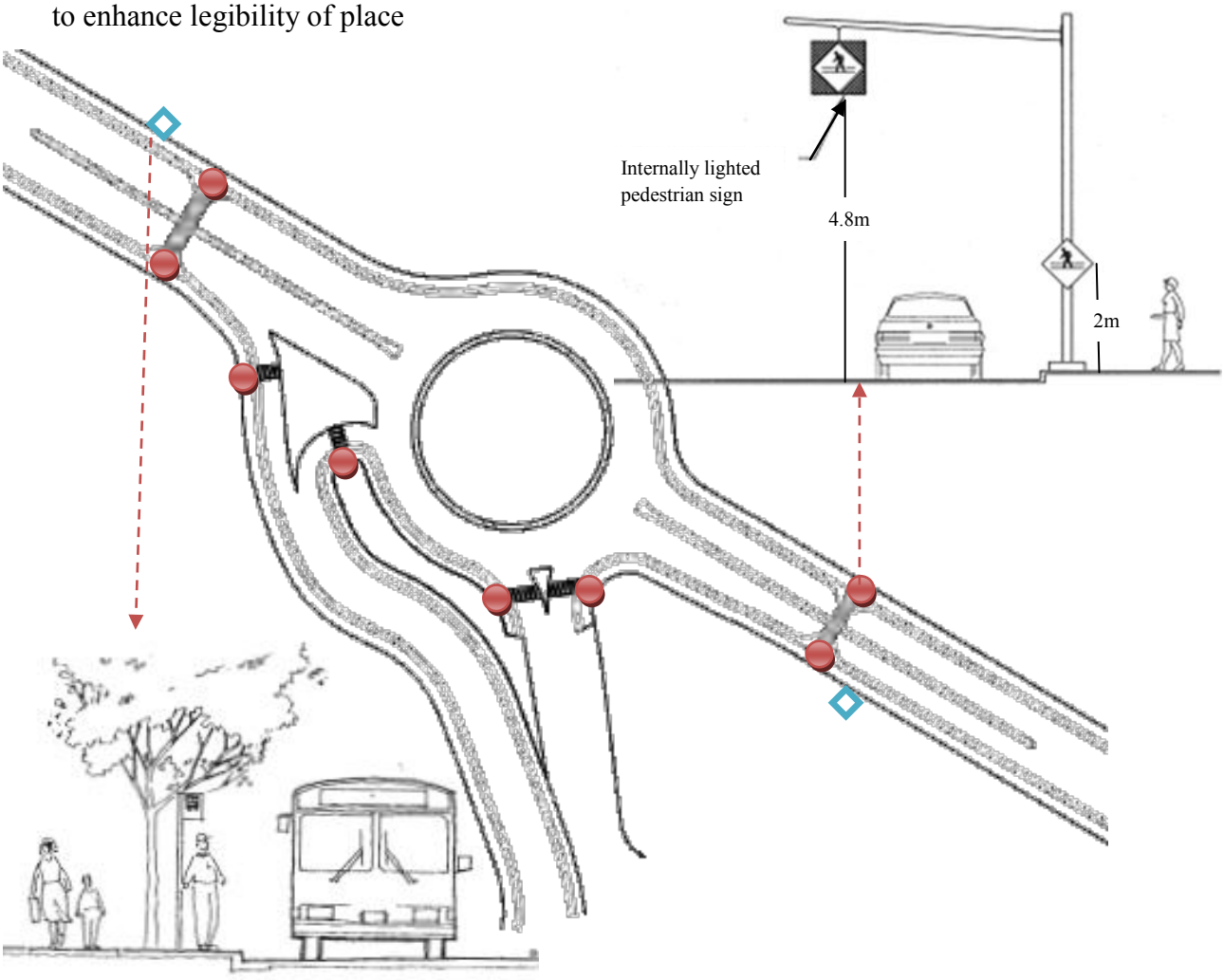


Figure 60. Pedestrian signs

- provision of high quality pedestrian facility by increasing clear width of sidewalks through zoning of sidewalk and removal of obstacles as well as delineating private and public space appropriately , high quality surface pavement, maintenance of existing facilities, provision of blind and disabled facility including ramp, curb ramp, textural cues and detectable warning surface

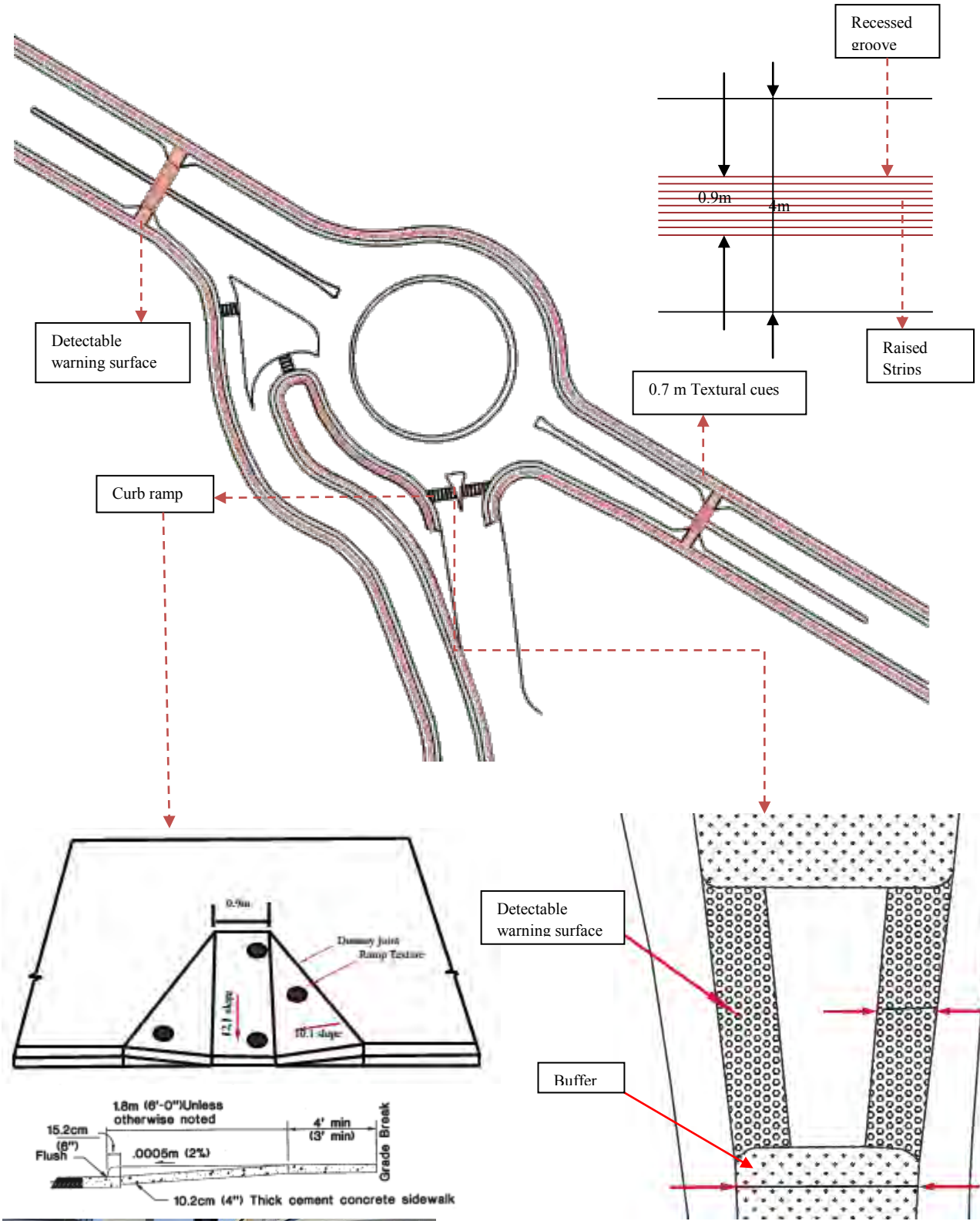


Figure 61. Disabled and blind pedestrian facilities

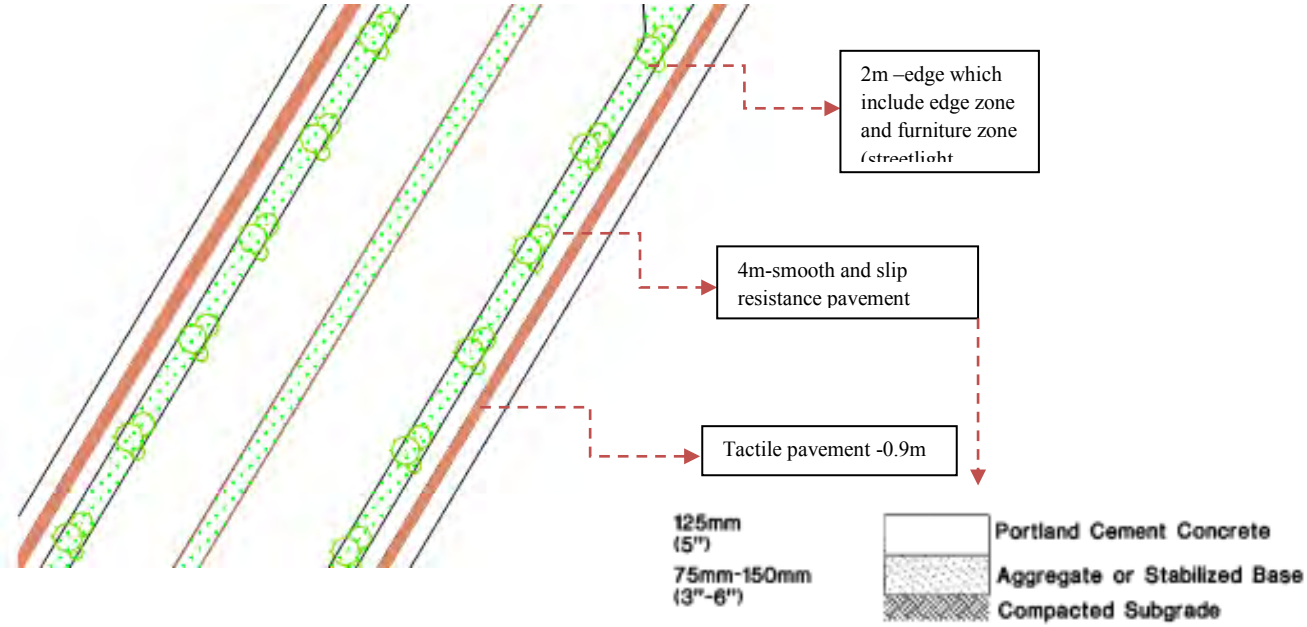
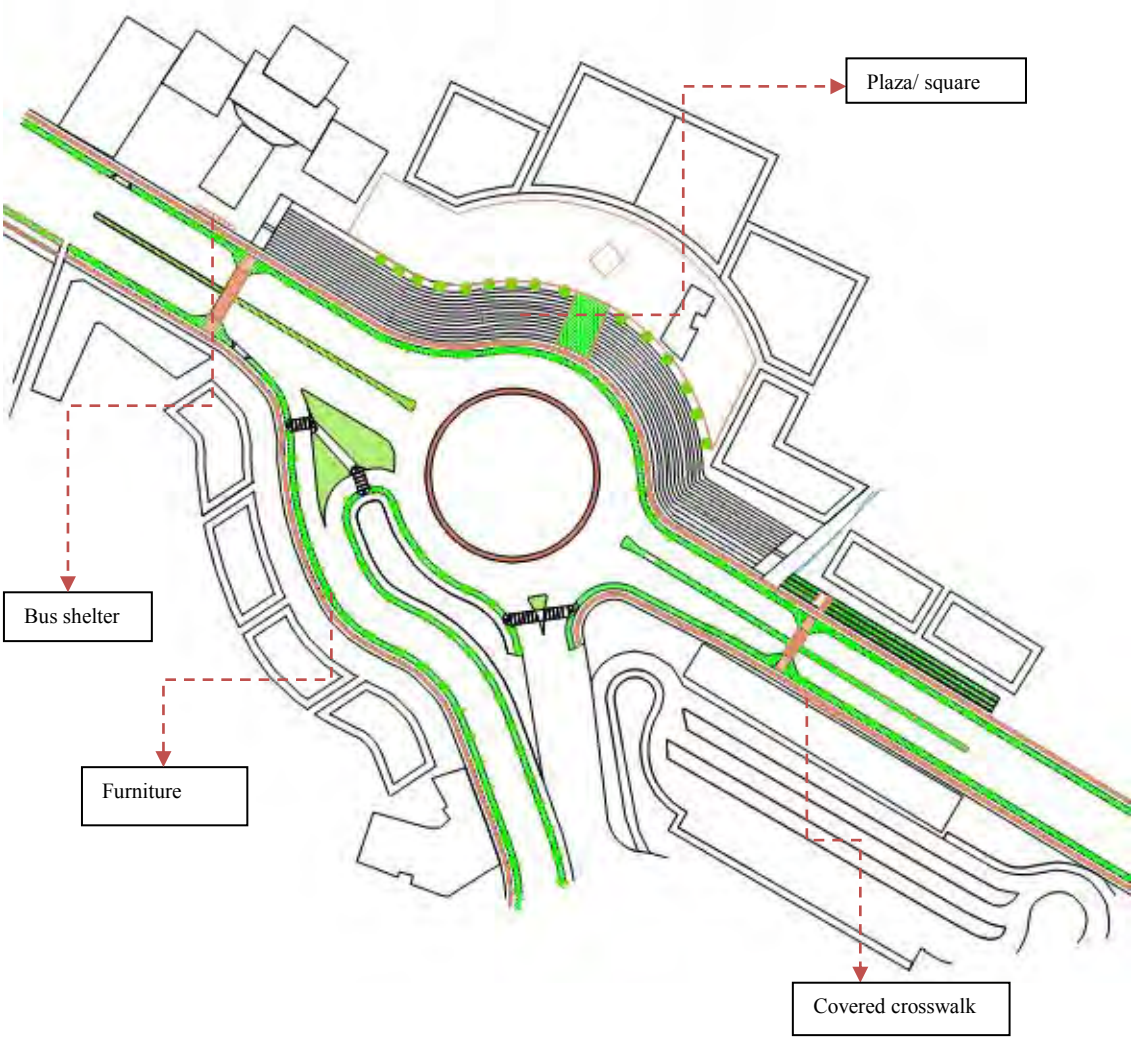
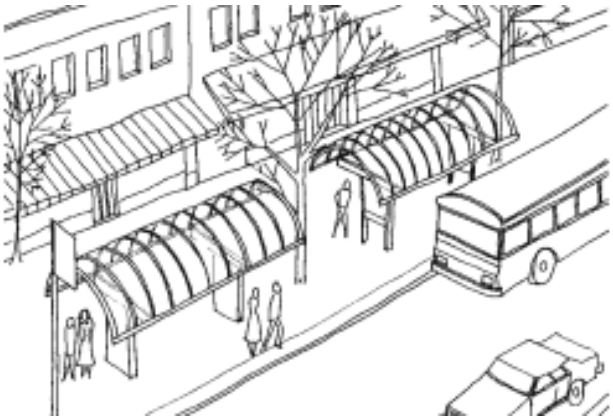


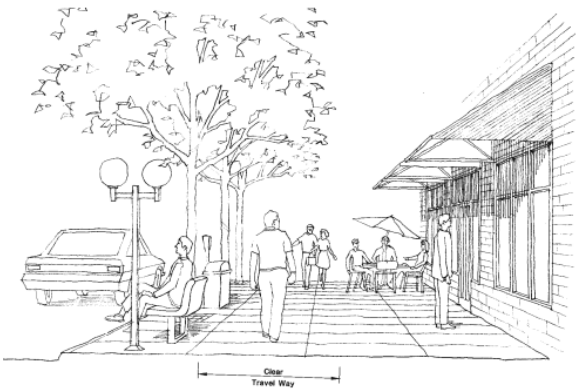
Figure 62. Quality pedestrian pavement

- provision of pedestrian facilities including benches, shades, buffer, pedestrian light, signs, information board, garbage can and appropriate location of sidewalk

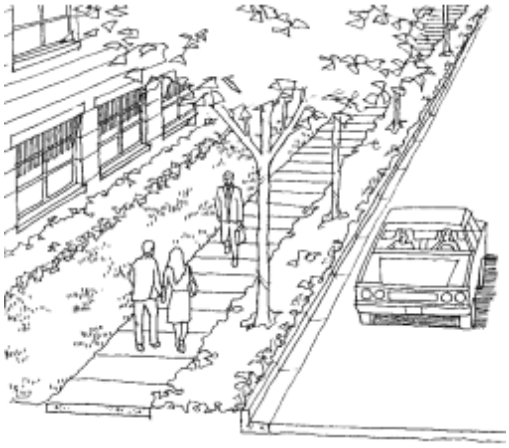




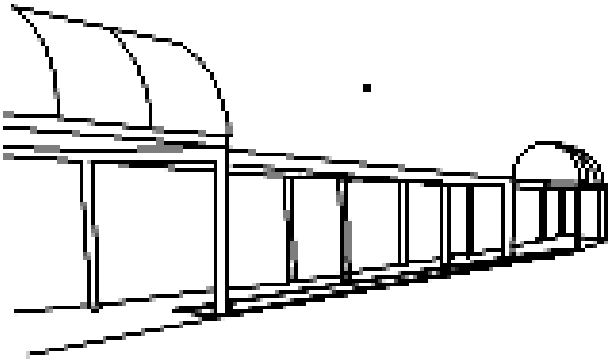
Bus shelter



Furniture zone; benches, pedestrian light, shade



Buffer zone between sidewalk and traffic lane



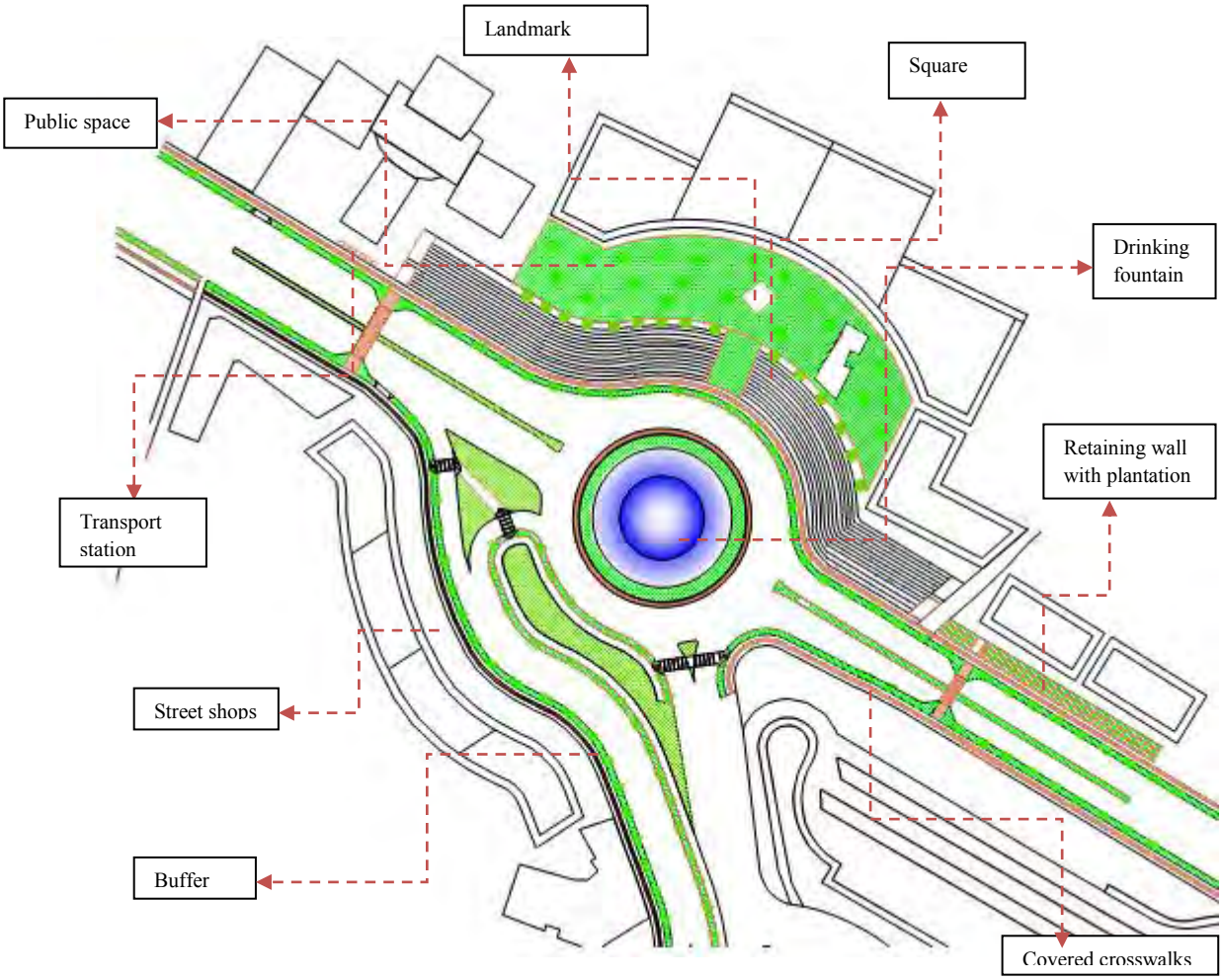
covered sidewalk

Figure 63. Pedestrian facilities

- Development of building with larger size or has higher number of window and door faced to roundabout on location which has less visibility and exposed to crime

Figure 64. Building facing roundabout

- Provision of public space and various pedestrian facility, public art like landmarks, fountain, attractive plantation and concentration of activity



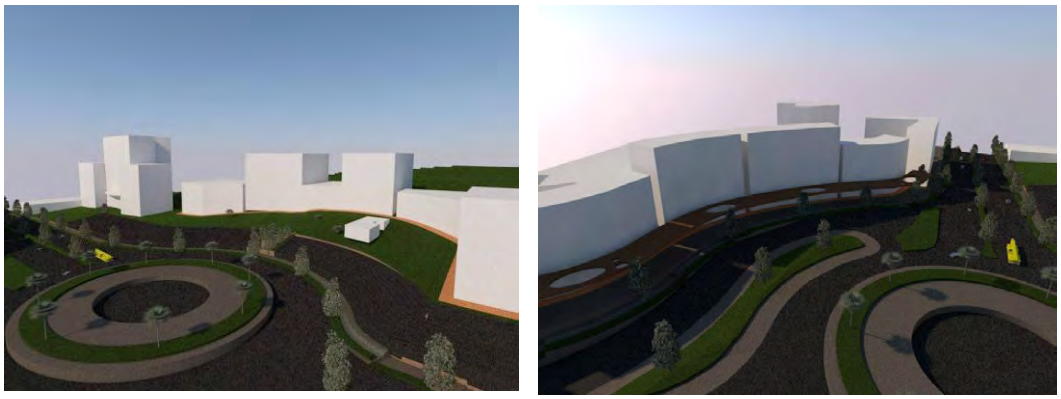


Figure 65. Public spaces

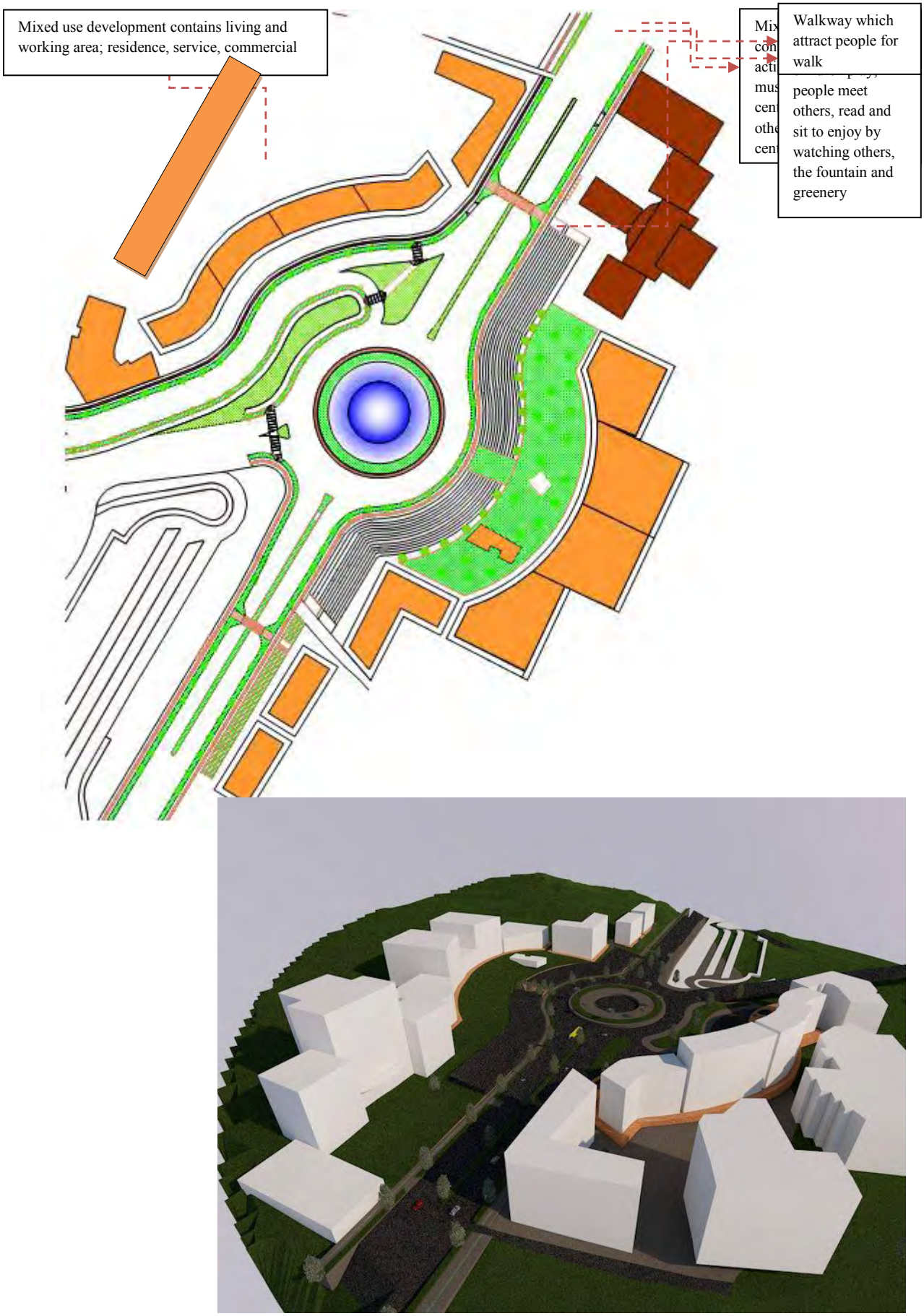


Figure 66. General design of the roundabout

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List of Annex

Questionnaire for MSC Dissertation on pedestrian perception of roundabout

Your responses to these questions will provide data relating to image of roundabout has inside people and there fulfillment of people which is important to analyze problems and give solution. So your participation is really appreciated.

1. What is your gender?

   a- Male b-female

2. What is your age?.....

3. Location of your living place……

4. What describe you best?

   a- Full time worker b-part time worker c-homemaker/retired/unemployed d-student

5. How many trip do you make to this roundabout?

   a- Three or more times a week b-one or two times a week c-once every one week d-once a month

   e- less than once a month

6. What is your major purpose of your trip?

   a- Working b-shopping c-school d-social gathering e-recreational d-transport e-other

7. How much time did it took you to arrive at roundabout?

   a- 5min b-10min c-15min d-more than 15min

8. How often do you feel that you could be robbed while you are walking to (from) roundabout?

Day time

   a. Almost always b-usually c-occasionally d-rarely

Night time

   a. Almost always b-usually c-occasionally d-rarely

9. How often do you feel, if you were mugged, that someone in the nearby houses or businesses could see you and help you and bring the mugger to police?

Day time

   a- Almost always b-usually c-occasionally d-rarely

Night time

   a- Almost always b-usually c-occasionally d-rarely

10. How often do you feel unsafe from crime were there are too few people on street?

Day time

a- Almost always b-usually c-occasionally d-rarely

Night time

a- Almost always b-usually c-occasionally d-rarely

11. How often do you feel unsafe from crime were there are more people on street?

Day time

a- Almost always b-usually c-occasionally d-rarely

Night time

a- Almost always b-usually c-occasionally d-rarely

12. On the roundabout, how fast does the traffic move?

a- Very fast b-somewhat fast c-somewhat slow d-very slow

13. When you try to cross the crosswalk found at the roundabout without a pedestrian light and sign, how often do drivers stop their cars and let u cross first?

a- Almost always b-usually c-occasionally d-rarely

14. While you are walking inside the roundabout, how often do u feel that crossing is dangerous?

a- Almost always b-usually c-occasionally d-rarely

15. On the roundabout, how often do you feel that crossing streets is dangerous b/c of fast moving cars on the street?

a- Almost always b-usually c-occasionally d-rarely

16. On the roundabout you walk on, how often do you feel that having more pedestrian crossing and pedestrian light signals will make crossing the streets safer?

a- Almost always b-usually c-occasionally d-rarely

17. Overall, how do you feel about crossing the streets?

a- Very dangerous b-slightly dangerous c-relatively safe d-very safe

18. How often do you feel that it is still dangerous walking on sidewalk b/c of cars entering driveways?

a- Almost always b-usually c-occasionally d-rarely

19. How often do you feel that a fast moving car could lose control and swerve into you while you are walking on sidewalk?

a- Almost always b-usually c-occasionally d-rarely

20. How often do you feel that putting waist high barriers between sidewalks and traffic lane will make sidewalks safer to walk?

a- Almost always b-usually c-occasionally d-rarely

21. How do you feel about the sizes of building on your routes?

a- Too big b-somewhat big c-I like them just the way they are d-somewhat small

e- too small

22. How do you feel about the building height on street u walk?

    a- Too tall b-somewhat tall c-I like them just the way they are d-somewhat short

    e- too short

23. How do you feel about the street width (more accurately "building to building across the street")?

    a- Too wide b-somewhat wide c-I like them just the way they are d-somewhat narrow e- too small

24. On your walk to the roundabout, how do u feel about the streetscape?

    a- Too enclosed b-somewhat enclosed c-I like them just the way they are

    d- somewhat expansive e- too expansive

25. How often do you feel that you have to wait too long at intersection to cross?

    a- Almost always b-usually c-occasionally d-rarely

26. Overall how do you feel about crossing streets?

    a- Very difficult b-somewhat difficult c-pretty easy d-very easy

27. How often do you have to step out of the way to avoid other pedestrians moving on the sidewalk?

    a- Almost always b-usually c-occasionally d-rarely

28. How often do you have to stop to avoid cars entering driveways?

    a- Almost always b-usually c-occasionally d-rarely

29. How often do you feel uncomfortable because the sidewalk is crowded?

    a- Almost always b-usually c-occasionally d-rarely

30. How often do you feel uncomfortable because of too much direct sunlight?

    a- Almost always b-usually c-occasionally d-rarely

31. How often do you feel uncomfortable because of noise, fumes or vibration from street traffic?

    a- Almost always b-usually c-occasionally d-rarely

32. Inside the roundabout, do you have stores or other services available for errands?

    a- Yes, plenty b- yes, enough c-no, no enough d-no, hardly any

33. How do you feel about the amount of landscaping of the trees on your walk to the roundabout?

    a- Yes, plenty b- yes, enough c-no, no enough d-no, hardly any

34. Visually, how do you feel about streetscapes you see on the roundabout?

    a- Very attractive b-somewhat attractive c-unpleasant d-ugly

35. On roundabout, are there interesting thing to see?

    a- Yes, plenty b- yes, enough c-no, no enough d-no, hardly any

36. How do you feel about the streetscape you enter to the roundabout?

    a-Very dull b-somewhat dull c-somewhat interesting d-very interesting

Thank you for participating in my MSC dissertation information audit.