ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY (AAIT)

SCHOOL OF CIVIL & ENVIRONMENTAL ENGINEERING

POST GRADUATE PROGRAM

ROAD AND TRANSPORT ENGINEERING STREAM

Assessing challenges and opportunities of non-motorized transport in Bahir Dar city

By

Getnet Mequanint

Advisor: Dr. Bikila Teklu

March, 2019

Addis Ababa, Ethiopia

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A thesis submitted to a school of graduate studies of Addis Ababa University in the partial fulfillment of the degree of Master of Science in civil Engineering (Road and Transport Engineering)

By

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Addis Ababa, Ethiopia

Declaration

I the undersigned, declare that this thesis is my original work performed under the supervision of my research advisor Dr. Bikila Teklu and has not been presented as a thesis for a degree in any other universities. All sources of materials used for this thesis have been greatly acknowledged.

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Date: March, 2019

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POST GRADUATE PROGRAM

This is to certify that the thesis prepared by Getnet Mequanint entitled, Assessing the challenges and opportunities of non-motorized transport in Bahir Dar city and submitted in partial fulfilment of the requirements for the degree of master of science in civil engineering (Road and transport engineering) compiles with the regulation of the university and meets the accepted standards with respect to its originality and quality.

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Chair person	Signature	Date

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List of abbreviations

NMT	Non-Motorized Transport
NCD	Non-Communicable Disease
MT	Motorized Transport
CBD	Central Business District
LOS	Level of Service
BDIDP	Bahir Dar Integrated Development Plan
NMPT	Non-Motorized Public Transport
NMVs	Non-Motorized Vehicles
LTTE	Lake Tana Transport Enterprise
MVs	Motorized Vehicles
WHO	World Health Organization
GDP	Gross Domestic Product
a.s.l	above sea level
CSA	Central Statistics Authority
HCM	Highway Capacity Manual
SPSS	Statistical Packet for Social Science

ABSTRACT

A deeper understanding of the challenges faced by the NMT users, and more importantly the cause of these challenges is more crucial when it boils down to delivering a safe and convenient system for all intervention (Mmanake Maria Mokitimi, Marianne Vanderschuren, 2016). The author tried to assess the challenges and opportunities of non-motorized transport or pedestrians and cyclists in Bahir Dar city. Non-motorized transport has various benefits as a mode of transport. But many current urban transportation planning designs does not take in to account the needs of vulnerable road users like pedestrians, cyclists and other slow moving modes. The objective of this thesis is to examine the existing non-motorized transport (NMT) challenges and opportunities that can be addressed by exploring the effective transportation planning and road design mechanisms.

The assessment were under taken by prepared questionnaire for pedestrians and cyclists about the existing facilities or sidewalks, presence of zebra crossing, obstacles on journey and other challenges and opportunities of non-motorized transport. The author were also used the three year traffic accident data from Bahir Dar city traffic police commission to determine causes of traffic accident on pedestrians and passengers, movement of pedestrians on the road and amount of accident occurrence, and injured pedestrians based on age and occupation.

The general non-motorized transport infrastructure rate by the respondents were grouped under satisfactory and poor. According to Bahir Dar city traffic police data 80.2% of traffic accidents were caused by over speeding, not giving priority for pedestrians and other vehicles and not drive by giving enough headway. Frequent pedestrian movements that cause pedestrian accident were 46.8% at pedestrian crossing point or crossing the road with and without zebra mark. The level of service of pedestrians and cyclists on selected route segments were also determined as LOS C and D. The pedestrian vehicle conflict study result shows that more conflicts were found at intersection crossing due to mainly drivers not priority for pedestrians and sever conflicts were found at mid segment due to over speeding and more parked vehicles on the road.

1. INTRODUCTION

Non-motorized transportation (also known as active transportation and human powered transportation) includes walking and Bicycling and variants such as small wheeled transport (skates, skateboards, push scooters and hand carts) and wheelchair travel. These modes provide both recreation (they are an end in themselves) and transportation (they provide access to goods and activities), although users may consider a particular trip to serve both objectives. For example, some people will choose to walk or Bicycle rather than drive because they enjoy the activity, although it takes longer. (TDM Encyclopedia, updated April 23, 2018). Non-motorized transport is the primary means of transportation for people in many developing countries and is essential to consider in the planning, design and modernization of transportation systems. (Paul Guitink, Susanne Holste, Jerry Lebo, 1994).

Though NMT users are the majority in many places, they are often neglected in the planning, design and modernization of transportation infrastructure. For example, new construction and upgrading often does not provide physical infrastructure (e.g., overpasses or shoulders) for existing NMT users, sometimes resulting in higher NMT-automobile accident rates, longer travel times for NMT users, or even a complete elimination of NMT traffic. The result of this neglect is a transportation system that in many ways favors cars and other motorized traffic to the detriment of poorer segments of the population; thus consideration of NMT during infrastructure design is an essential element to providing equitable transportation opportunities. (Paul Guitink, Susanne Holste, Jerry Lebo, 1994).

Most European cities give priority on non-motorized vehicles on certain streets and intersections when planning and designing green phases at traffic lights. Some one-way streets have been transferred into two-way streets for the purposes of non-motorized moreover non-motorized vehicles are exempted from many turn restrictions for cars. Some European cities have dedicated car parking space to non-motorized lanes or non-motorized parking. In case of Malaysia the same move can be done by upgrading the non-motorized facilities. Malaysia needs to focus on planning and designing networks in neighborhood areas and focuses on linking with existing road infrastructure to improve non-motorized quality. These can be achieved by implementing European model of non-motorized transportation. **(**M. R. Mat Yazida*, 2011**).**

In Bahir Dar, the modes of transport used by low-income groups for the movement of people and goods have lost out competition for policy attention and funding by municipal government bodies. Walking, cycling, and the operation of horse-drawn carts have best suffered from neglect. Horse-drawn carts in the town operate in the hostile road surfaces of local and collector streets with high level of danger and insecurity, especially to women and children. (Yayeh Addis, 2003).

It is important to develop a traffic management strategy on the roads of the town by establishing functional hierarchy of roads and allocating road space to priority users, including bicycles and horse-drawn carts. In Bahir Dar, these factors are quite relevant because the mixture effects of different types of vehicle use on the same road leads to high potential risks especially for non-motorized road users. Thus, the segregation or separation of road user types, such as the construction of bicycle lanes, but also banning vehicles with hazardous freight from the main routes will substantially improve safety. The provision of off-road parking spaces or the establishment of some forms of parking control may reduce conflicts and increase road capacity and safety. (Yayeh Addis, 2003).

1.1 Historical back ground and Transport history of Bahir Dar city

The historical foundation or origin of City of Bahir Dar is associated with the establishment of Kidane Mihret Church in the present site of St.Giorgis Church around the century of 14th. Beginning from that time it was established as a rural village on wards it has developed into one of the current largest city of the Ethiopian country. According to the information, its fastest development and transformation into a modern town ship was made during the Italian occupation period of 1928-1933 since it was used as a major military base for their expeditions in the region. The naming of the city called as Bahir Dar has a connection with its near proximity to the two water bodies of the surrounding (Lake Tana and River Abay). This means periphery of a water body, which may be a periphery to one of them or both of them. As far as the reasons for its foundation are concerned, the availability of the two water bodies and the foundation of Kidane Mehiret Church or now at the place of St.Giorgis church in the area were the major responsible reasons among others. (BDIDP, 2006)

Now a day the city is also equipped with an airport with paved runways, identified by the ICAO code HABD and IATA BJR; Ethiopian Airlines operates scheduled flights both day and night

between Bahir Dar and the capital as well as with Gondar to the northwest. The city is also connected through roads (and bus lines) to other cities. The most common and convenient way of traveling in Bahir Dar is cycling. Taxis also provide efficient transportation in the city. Executive intercity bus service is provided by the Selam Bus, Sky Bus, Abay bus etc. amongst other private investors is in plenty. (Bahir Dar Institute of Land Administration, 2016).

1.2 Statement of the Problem

The current urban transportation-planning paradigm does not take into account the needs of vulnerable road users like pedestrians, cyclists and other slow-moving modes (Anvita Arora, 2013). There are various benefits to Non-motorized Transport (NMT) as a mode of transport. Safety benefits of successful NMT facilities include lower risk of road collisions, injuries and fatalities, while there are also several health benefits of NMT trips, which include lowered levels of stress, obesity and other Non-Communicable Diseases (NCDs). NMT, as a mode of transport, is one of the most sustainable modes of transport, as it does not rely on fuel and, is one of the cleanest modes of transportation. Although many people automatically think of traffic as Motorized transport (MT) traffic and never realize that NMT traffic is there just as well, in most African cities including Ethiopia NMT trips outnumber MT trips. But infrastructural and policy planning activities of most urban and rural roads of Ethiopia are not consider the proper design and provision of these non-motorized transport facilities including Bahir Dar city.

NMT have tended to be ignored by economic and spatial planners, road engineers and policymakers in the formulation of infrastructure policy and positively discouraged as a service provider. There are various challenges facing NMT, as a mode of transport, in urban areas of many Ethiopian cities, which include issues related to policy, strategies and budgeting for NMT facilities and programs, as well as poor education and training for both NMT and other road users. External challenges that affect NMT trips include poor enforcement of road regulations, security concerns (crime), the lack of integration between NMT facilities and other modes of transport facilities, as well as land use planning that does not support NMT, as a mode of transport.

1.3 Research Questions

- What is the current level of NMT (cycling and walking) within the city of Bahir Dar compared to other modes of transport?
- What are the challenges and potentials of promotion of NMT within the Bahir Dar city to enhance safety and mobility?
- What are the factors or causes that contribute to non-motorized transport accident?
- What kind of alternatives remedies with specific reference to physical infrastructural interventions that can promote sustainable NMT within Bahir Dar city?

1.4 Purpose of the study

The overall aim of this study is to highlight the existing non-motorized transport condition or infrastructural facilities and challenges and opportunities for non-motorized transport or especially for cycling and walking within the city of Bahir Dar, which is the capital city of Amhara regional states, Ethiopia. The study have underlined characteristics, challenges and benefits for NMTs and, to suggest a framework within which NMT's potential may be better exploited, to enhance the urban mobility within the city of Bahir Dar.

1.5 Objectives

1.5.1 General objectives

The general objective of the study is to assess the challenges and opportunities of non-motorized transport systems (NMT), determine pedestrian and Bicycle level of service and conflict analysis on selected route link and segments, and propose remedial measures to the problem of non-motorized transport in Bahir Dar city, Ethiopia.

1.5.2 Specific objectives

The specific objectives of the study are;

- To determine the current non-motorized transport mode (cycling and walking) level of usage within the Bahir Dar city compared to other mode of transport.
- To examine the existing non-motorized transport (NMT) challenges and opportunities that can be addressed by exploring the effective transportation planning and road design mechanisms.
- To investigate the factors that contribute to non-motorized transport accident risk causes at existing road sections.
- To propose alternative remedies with specific reference to physical infrastructural intervention that can be introduced to promote the sustainable non-motorized transport (NMT) within Bahir Dar city.

2. LITERATURE REVIEW

2.1 Non-motorized transport in the world

The variation in rates of death observed across regions and countries corresponds with differences in the types of road users most affected. Vulnerable road users – pedestrians, cyclists and motorcyclists – represent more than half of all global deaths. Pedestrians and cyclists represent 26% of all deaths, while those using motorized two- and three-wheelers comprise another 28%. Car occupants make up 29% of all deaths and the remaining 17% are unidentified road users (WHO, 2018). Non-motorized transport provides many benefits to users and non-users alike, including travel choice, and mobility, affordability, reduced road congestion, infrastructure savings, improved health, recreation and enjoyment, environmental protection and economic development (Todd,Litman et al, 2008). Non-motorized transport (NMT) is a key component of urban transport system worldwide, but in developed countries, we generally think of NMT in terms of private transport: walking and cycling.

On average, about 37% of journeys in cities are non-motorized. In some African cities, over 80% of journeys are made on foot. Population growth and urbanization will add 2.5 billion people to the world's urban population by 2050, with nearly 90% of the increase concentrated in Asia and Africa. The new Sustainable Development Goals include targets on cities which call for "safe, affordable, accessible and sustainable transport systems for all". Putting people first by supporting walking and cycling will help create livable and sustainable cities. (FIA FOUNDATION, 2016).

Biking and walking are rather neglected transport modes within transportation research. In terms of their contribution to the total number of kilometers travelled, their share is indeed small in most countries. However, their share in the total number of trips made is substantial almost everywhere. In less developed countries walking and biking are the natural transport modes for low income households, but also in many countries with higher incomes they are considered important transport modes. (Piet Rietveld, January 2001)

As NMT share is declining rapidly in developing countries like India, it is very much necessary to pay attention to implement certain measures in order to establish a sustainable healthy transportation system which is inclusive of NMT modes. In developing countries as the trip lengths are increasing day-by-day, it is necessary to make use of the multimodality behavior of

non- motorized modes in order to reduce severe traffic congestion thereby improving the journey speeds. The development of NMT mode choice models are mainly hindered by the improper data collection i.e. missing of data regarding slow modes etc. So keeping in view the impact of above discussed factors on NMT share, while data collection it is necessary to focus on individual attitudes and perceptions towards various modes, non- motorized facilities and neighborhood characteristics prevailing in the survey area, trip related information in addition to the household socio- demographic information. As the life style, geographical characteristics etc. are much varied between developed and developing countries it is not entirely possible to follow the regulation measures which are implied by the developed countries to boost up NMT but some measures which are applicable for developing countries may be chosen wisely. (Santhi J Bedadala, Mallikarjuna, 2016)

Logical integration of walking, NMV modes, and motorized transport will enhance the modernization of urban transport. As the Authors research the Kenyan cities, where major shares of trips are made by walking and cycling, NMVs have an important role to play in urban transport systems. This research have demonstrated that successful integration of non- motorized transport in environmentally sustainable transport strategies, aimed at creation of well-balanced transport system, depends on the developments of NMT facilities, educations, encouragements and enforcement of traffic laws availability that will promote road safety, and image of non-motorized vehicles**. (**Okoth Charles Ameso Angira, 2013).

No matter where everybody lives or how everybody travel, nearly everyone begins and ends each trip as a pedestrian or walking. In cities across most Africa, most people rely almost exclusively on walking and cycling as their primary forms of mobility. Due to a lack of non-motorized transport infrastructure, however, people spend several hours each day walking to and from school and work and accessing basic services. (Carly Koinange, 2016).

Recent studies show that between 25 and 50 percent of trips in the major Indian cities,1 and around 50 percent of all trips in major African cities, are entirely on foot, and that trips undertaken primarily by public transport also involve significant walking distances. In medium and smaller cities, the share of all-walking trips increases to 60 to 70 percent. Clearly, walking dominates for shorter trips, but even in terms of distances traveled, walking accounts for over 50 percent of all trips in Morogoro, Tanzania.

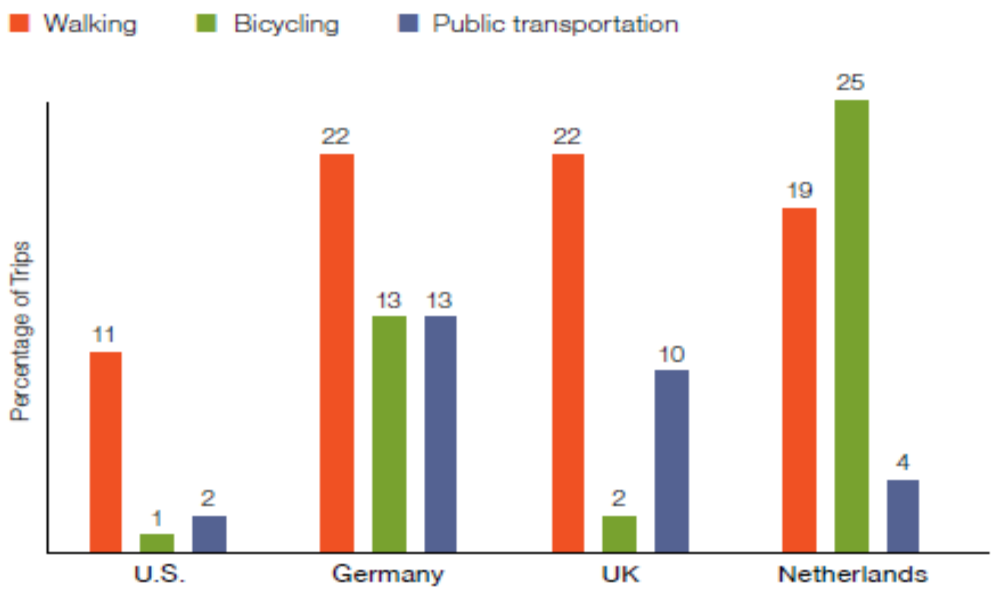

Figure 2. 1 Rate of non-motorized transport in US and western European countries (Source; moving towards active living transport, 2016)

2.2 Non-Motorized Transport (NMT) in Ethiopia

In long history of Ethiopia, walking and bicycling as a mode of transportations were among the earliest modes in human history both for passengers and freights. Motor vehicles has invented as a result of development in the transportation system which in turn resulted in reduced use of non-motorized transport. Further development of motorized transport system negatively influenced the use of non-motorized modes so that non-motorized modes of transportation are on their ways to be fully replaced by motorized transport. Development in transportation infrastructures and services largely contributed for human being's advancement and dramatically reduced the effect of physical distances bringing distant places closer to each other. However, these advantages of motorizations were not without negative effects. Motorized transport was one of the responsible factors for deaths of many and for the prevailing degraded natural environment at world scale. (Gebrechristos Nuriye, 2014).

Non-motorized transport (NMT), and particularly dominates the modal split for daily trips in Addis Ababa, making up approximately 62% of total trips. Despite this there is currently poor provision for non-motorized transport in the city with over 60% of the street network lacking footways. Walking also suffers from unsafe crossing points along many roads, including major urban highways which are often wide with no pedestrian priority. Access on foot to bus stops

along the demonstration bus priority corridor is often inconvenient or faces hazards. Poor provision is reflected in the number of road accidents in Addis Ababa, which are increasing by 12% per year. (Debashish Bhattacharjee, 2012)

In Ethiopia, medium sized cities are the most bicycle-friendly places. But in Primate City, Addis Ababa, and tertiary cities there is deficient of non-motorized transport mode. In medium sized cities of Ethiopia more dominant users of bicycles are found to be government employees relatively who are medium and low income as well as at the age group of 15-45. For instance, the most frequent bicycle users in Bahir Dar and in Hawassa city are government employees (46.15% and 42% respectively). Rapid growing trend of bicycles and Bajaj's in these secondary cities has negatively affected the growth and the role of taxis. Such kind of shift can be put as a huge modal revolution in Ethiopia. (Belew Dagnew Bogale, 2012).

Hawassa is one of the emerging secondary cities in Ethiopia that has been enjoying walking and bicycling as preferred mode of transport for several years. However current situation of Hawassa has been changed and as a result walking and the use of bicycling have been steadily decreasing. Results from the household survey have shown that absence and insufficiently operating facilities for non-motorized transport modes have discouraged the use of these transport modes. Lack of infrastructure, for instance, absence of pedestrian crossings, lanes and parking places for bicycles were affecting the use of non-motorized transport modes. (Gebrechristos Nuriye, 2014).

Whereas the majority of Ethiopian urban population covers short- and medium-range distances on foot or by walking, in the urban areas people for the most part travel on foot, save for those limited instances where they use draught animals (Tesgen Aklilu, 2001).

2.3 Non-Motorized Transport in Bahir Dar city

According to the information gained from the city municipality, there are about 1581 private bicycles, 475 government bicycles and considerable numbers of bicycles owned by different organization. As the result of surveying different private bicycles there are more additional bicycles which have not given plate numbers. The municipal of the city or authority of road and transport has not given much attention or consideration about the usage of non-motorized transport especially for cycling and walking. Therefore, the use of non-motorized transport by the city of people is very low. It became less and less from time to time.

There are also more than 100 horse-drawn carts to transport goods and commodities from place to place. These horse drawn carts are very important to transport goods and commodities from surrounding rural area to the urban center. Farmers use these horse drawn carts to carry their crop products and plants/ woods to their home and to the market of Bahir Dar city. But there is no comfortable road facility condition due to fast moving vehicles and congestion of the road.

In addition to bicycles and horse drawn carts, there are also man powered non-motorized transport systems called hand drawn carts. These hand drawn carts are more increasing in the recent time in the city. On average, they can carry up to 200kg goods and commodities. Their main usage is concentrated around the place of market, stores, grinding house/ woficho bet/, mini and super markets, shops and at different places of the city

2.4 Road transport and infrastructures in Bahir Dar city

Bahir Dar city is the capital city of Amhara regional state has a total bounded area of **62.37** km^2. The city has favorable topographical feather and environmental condition for non-motorized transport especially, for cyclist and walkers. Since the city is the center of many natural resources like Lake Tana and different species of trees, man made things such as hotels, it attracts different country tourists and peoples of the country. Therefore, there must be sufficient safe transportation facility for non-motorized transport system in addition to motorized transport system. According to the road survey of the Bahir Dar city municipality the city has an equivalent (7m width) length of 667.25km road or 6.54 km^2 total areas within the road reserve. According to this data the Bahir Dar city has 10.50% percentage of the city area occupied by the road.

Table 2. 1 The extent of the city's road network

Service component	Unit of measurement	Quantity (to be provided)
Land areas within the city boundary	km^2	62.37
Equivalent (7m width) length of road	km	667.25
Total area within the road reserve	km^2	6.54
Percentage of the city area occupied by the road reserve	%	10.50

Source; inventory result of Bahir Dar municipality

The city has primary, secondary, collectors and local roads which are constructed from asphalt, cobble stone, red ash, compacted earth, gravel earth, earthen road and large block stone. Asphalt

road is mostly constructed on primary road type and cobble stone, red ash earthen road types are constructed on collectors and local road types. Among these road types collectors and local road types are high in length or present in high proportion.

Table 2. 2 Summary of total road coverage in Bahir Dar city

Road Surface	Primary Road (KM)	Secondary Road (KM)	Collectors and Local Road (KM)	Total
Asphalt Road	97.43	9.11	27.33	**133.87**
Cobble Stone Road	1.74	3.91	100.72	**106.36**
Red Ash Road	5.76	0.47	223.76	**229.99**
Compacted Erath Road	0	0	5.44	**5.44**
Gravel Road	0	0	1.36	**1.36**
Earthen Road	1.33	0.07	188.5	**189.9**
Large Block Stone	0	0	0.33	**0.33**
Total	**106.26**	**13.56**	**547.44**	**667.25**

Source; Bahir Dar city municipality road asset management team;

2.5 Greenery, park and recreational areas in Bahir Dar city

Bahir Dar city has various species of green plants/forests of either natural or artificial (manmade) types. The dominant species of greenery in the city are Eucalyptus, Zembaba and many more other plant types. The latter is dominantly planted along the sides of the roads as a shed tree and beautification. These shed trees are used to protect pedestrians and cyclists from sun light because the city becomes sometimes hot and creates uncomfortable living condition during day time. And also greeneries/forests are used to attract people to walk and use cycle to drive. Regarding to parks and recreational areas, there have been a number of parking areas that are used as a recreational area in the city of Bahir Dar. To mention some of them “Hidar 11” with 45500 m^2, “Shum Abo” with 16250 m^2, “Meskel Adebabay” with 48720 m^2, and “Koteta Terara” with 151600 m^2 area are the most notables. Mango and Bingo parks are the other most two important areas, which have been administered under Lake Tana Transport Enterprise (LTTE).

Non-Motorized Transport (NMT) infrastructure consists of dedicated walkways, measures to prevent motor vehicles from driving and parking on road shoulders and walkways, construction of missing links, short cuts, and of bicycle lanes and dedicated cycle tracks. Traffic calming measures included intersection re-design of some intersections to increase their safety and

efficiency for NMT, speed humps, raised zebra crossings, pedestrian crossing islands, medians, road narrowing with bicycle slips, and bus bays.

2.6 Bicycles and Walking in Bahir Dar city

2.7.1 Bicycles

Bicycles are the predominant non-motorized transport mode in the town of Bahir Dar next to walking (accounting for 30 percent of trips), and offer low cost personal mobility assisting lower income groups. However, increasing motorization has increased safety problems for bicycles particularly in mixed traffic heavily used streets and intersections. In the town providing convenient and good quality facilities for cyclists is a low priority. There is a view in some government officials during the discussion that bicycles are considered to impede motor vehicles, and are categorized as the least transport hierarchy. The tendency is, therefore, towards elimination of cyclists rather than provision of good facilities for their use. But bicycles are an efficient mode, suitable for various urban journeys and available to at least most of the social groups of the community. Therefore, bicycles should be treated as an integral part of the traffic management system and strategies should be designed to improve safety by protecting cyclists from conflict with motor vehicles and pedestrians.

Bicycle lanes or tracks should be purposely constructed or created by re-allocating existing road space to provide separate lanes and use local streets with supplementary infrastructure. Clear traffic management rules and measures should be developed on existing roads to assist and control cyclists from road safety problems. It is desirable that cycle traffic be governed by rules intended to promote safety. Some of the common rules strictly adapted are: all cycles should be provided with good brakes and should have night lamps and red reflectors at the rear. Where no separate cycle track is provided, the cyclists shall keep to the extreme right way. Double riding should be controlled and cyclists should not use foot ways of pedestrians. (Yayeh Addis, 2003).

Poor pedestrians manner in giving priorities to vehicles where necessary was statistically significant factors for the occurrence of road accidents at Bahir Dar city and researchers concluded that there is better to make awareness for pedestrians to minimize the traffic accident in the area. Using seat belt sometimes while driving was statistically significant for occurrence of accidents at Bahir Dar City and this showed that awareness for drivers to use seat belt always is

necessary to minimize the occurrence of accidents. (Haile Mekonnen Fenta, Demeke Lakew Workie, 2014).

2.7.2 Walking

In Bahir Dar, pedestrians are the road users most affected by road traffic accidents. Between 52 and 64 percent of all road accidents are pedestrians. Especially, school children under the age of 15 years are highly vulnerable to road accidents. Drivers, passengers and two-wheeled vehicles are also frequently involved in traffic crashes. Results also show that the risks are higher among males, particularly those who are economically active age group of 18-50 years. In between 1995/6 and 2001/02, on the average, males accounted for 75 percent of all casualty cases in the town. (Yayeh Addis, 2003).

The survey results indicate that, of all road traffic accidents of Bahir Dar, 82 percent were caused by motor vehicles (cars and taxis). The traffic flow is too mixed and no distinction of flow for different modes is observed. Cycles and motor vehicles are usually parked on pedestrian paths, and pedestrians including animals walk in the center of roadways .Moreover, heavy trucks use almost all routes without any restrictions or regulations. (Yayeh Addis, 2003).

In Bahir Dar foot ways are often obstructed by long trees, signs of advertising, illegal parking, hawkers and traders, encroachment of shop displays, and in some streets foot way dwellers (.St. George to Mota road). Under these conditions, footways are un-usable and pedestrians are forced to walk in roadways with both safety and traffic congestion problems. Therefore, town governments should take enforcement actions against illegal parking on the main roads hazardous and obstructive locations. Tall vegetation at the intersections and junctions should always be cut and equitable policies for relocation of street traders and footway dwellers should also be carried out.

The large cities suffer from a severe backlog in pedestrian infrastructure, and offer a high potential to improve walking infrastructure facilities. (V. Setty Pendakur, 2005).

2.7 Problems of non-motorized transport

NMT users are exposed to fast, aggressive and high MT volumes with the consequences of high traffic accidents. Encroachment of NMT spaces is rampant and vulnerable road users, women and children have difficulties travelling without assistance (Nairobi city county government, 2015). Accessible and affordable public transport service and safe infrastructure for non-

motorized transport such as cycling and walking are lacking in most developing country cities. The number of private vehicles has been increasing continuously and dominates the roads. As a result, the transportation sector is heavily responsible for public health issues in cities such as air pollution (acidification, smog), noise, greenhouse gas emissions, and road accidents. While transport enables the economy to grow, if not well-managed, it can also retard growth and the efficient delivery of essential social services. (Shanghai Manual – A Guide for Sustainable Urban Development in the 21st Century).

Challenges of walking; Road traffic crashes kill about 1.24 million people each year. More than one fifth of these deaths occur among pedestrians. Pedestrian collisions, like all road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable. Key risk factors for pedestrian road traffic injury are vehicle speed, alcohol use by drivers and pedestrians, lack of safe infrastructure for pedestrians and inadequate visibility of pedestrians. Reduction or elimination of the risks faced by pedestrians is an important and achievable policy goal. Proven interventions exist, yet in many locations pedestrian safety does not attract the attention it merits. (WHO, 2013).

While sidewalks support healthy and active communities, they do not come without their challenges. It is easier to design sidewalks into new developments than it is to retroactively construct them into an already built context. It is critical to find the appropriate distribution of space between competing uses within the right-of-way, and to ensure that sidewalks are designed and maintained properly to allow for safe and inviting use by pedestrians. (City of New York, 2013).

2.8 Advantage of Non-Motorized Transport (NMT)

Non-motorized transport provides many benefits to users and non-users alike, including travel choice and mobility, affordability, reduced road congestion, infrastructure savings, improved health, recreation and enjoyment, environmental protection, and economic development (Todd Litman, et al, 2009). Walking and cycling provide numerous benefits: fresh air breathing, no fossil fuels usage, has health benefits and uses less land space compared to other modes of transportation. This dividend of NMT can only be achieved through facility construction that complies with the necessary environmental sustainability and protection. (Nancy Abira, 2014).

Walking and cycling provide numerous benefits and opportunities. They include in broad terms: environmental sustainability; employment generation opportunities; public health improvements; reduction in household travel costs; increased time savings for productive use, like studying for school children; and use of less land space compared to other modes of transportation (Nairobi city county government, 2015).

Encouraging walking and cycling saves households time and money, and is essential for the long-term protection of health and the environment. Non-motorized transport, such as walking and cycling, can substantially increase the levels of regular physical activity. (Ralph Buehler, Thomas Gotschi and Meghan Winters, 2016).

Transport benefits; Many trips daily are less than three miles in length, yet 72 percent of these short trips are made in vehicles. According to Jeroen (2009) who mention that bicyclists and walkers can often bypass congestion and gridlock traffic, and in some instances may even arrive at their destinations faster than if they had driven a car. Accommodating bicyclists and pedestrians also ensures that individuals have transportation choices aside from driving a car or being driven (Okoth Charles Ameso Angira, 2008)**.**

Flexibility; NMT provides a flexible form of transport where it is needed most-in activities that are essential to the basic quality of life. People living in poverty face a wide variety of everyday problems related to mobility, such as access to employment, social services and activities, educational opportunities, and household chores. NMT is a multi-purpose tool that can be used for the door-to-door transport of persons and goods with improved travel time and route options. (Nancy Abira, 2014)

Affordability; Transport has to be affordable to users. While buses may be affordable at the beginning of the month, fares often become prohibitive with dwindling cash over the following weeks, and people are left with no choice but walking. Affordability of NMT is a function of purchase price in relation to income. Operational costs rarely are a constraint. However, high retail prices frequently suppress the potential demand for NMT, such as bicycles, carts and spare parts. (Nancy Abira, 2014).

Accessibility; Safe walking and cycling routes can increase people's access to jobs, schools and healthcare, while allowing limited incomes to be spent on other daily essentials. The new

Sustainable Development Goals include targets on cities which call for "safe, affordable, accessible and sustainable transport systems for all". Putting people first by supporting walking and cycling will help create live able and sustainable cities (FiA foundation, 2016).

Reducing emissions; Pedestrians, bicyclists and cycle rickshaw passengers generate no air pollution, no greenhouse gases, and little noise pollution is created. Reducing these emissions and noise are critical to slowing global warming, reducing incidents of asthma and other upper respiratory and cardio-vascular disease, and reducing sleep disorders. In both developed and developing countries, upper respiratory illnesses, particularly asthma, are increasing dramatically. While emission standards and cleaner vehicles can greatly reduce certain emissions, reducing carbon die oxide, nitrogen oxide, and ground level ozone through tailpipe-focused measure alone is proving exceedingly difficult. These emissions are growing rapidly in most developing country cities as the use of motor vehicles increases. (Walter Hook, 2003).

2.9 Topographic Advantage for Non-Motorized Transport at Bahir Dar city

At the southern end of the Lake is a relatively gulf area where the town of Bahir Dar is located. However, there are also higher elevation places which have some domes and ridges with relatively higher elevations that standout in the area, particularly to the west and south of the town. Elevation variation in the area ranges from 1,786m a.s.l to 1,886m a.s.l at else place. The town stretches over a predominantly flat land with imperceptible slope changes, except for small rises in its eastern and western peripheries. The slope varies from apparently zero to slightly over 20 percent in few places. Most parts of the town, however, stretch on areas below 2 percent slope. This good topographic environment makes suitable for pedestrians, cyclists and in general for non-motorized transport systems (BDIDP, 2006),

2.10 Road side furniture's within Bahir Dar city

2.11.1 Street seating

Street seating or road side seating gives to an active pedestrian environment or participation by increasing the role of the sidewalk as an enjoyable public space. Seating serves as a short-term need to rest or wait, and it also increases socialization and enjoyment of the urban environment. Examples of public seating include fixed benches, sitting rounds, seats built into other amenities like landscape planters, and even movable chairs and tables.

In Bahir Dar city there are some street seating facilities along the side of the road that are distributed at the cities of Bahir Dar. But there is no enough street seating to satisfy the pedestrian of the city. The result of undocumented inventory of street furniture shows the number and distribution of street seats in the city.

Table 2. 3 Inventory Result Summary of Street Furniture

Name	Location	Material	No
Street Seats	Distributed through the city	Concrete	180
	Distributed through the city	Steel	11
	Distributed through the city	Timber	10
SUB TOTAL			**201**
Flower Box	Sefene Selam Sub City	Concrete	40
TOTAL			**241**

Source; Bahir Dar city municipality road asset management team

2.11.2 Street light road facilities

Street lighting provides a necessary road function by illuminating the roadway and sidewalk area to ensure safety, security, and accessibility for all road users. Pedestrian street lighting of the sidewalk area creates a safer and more enjoyable pedestrian realm. In Bahir Dar city there is somehow a street light facility at the side of the road, especially at primary and secondary road sections. Street light types and the type of material it is constructed or steel pole, wooden pole and concrete are different in different place of the cities road.

Table 2. 4 Distribution of Street Light by Type

Street Light Type	Number	Percentage
High pressure Sodium Lamp	1087	36.67
Light Emitting Diode	950	32.05
Florescent	865	29.18
CFL	62	2.09
Total	**2964**	**100.00**

Source; Bahir Dar city municipality road asset management team

2.11.3 Street trees and landscaping

Street trees and landscaping are essential to attract passengers, enjoyable and for sustainable urban environment or movement. They provide numerous aesthetic, environmental, health, and even psychological benefits. Therefore, Bahir Dar city has special and unique identification

character which is the presence of Zembaba and other more attracting plants along the side of the road and at the median. The presence of this plant makes people to be attracted and move as a pedestrian.

Table 2. 5 Inventory Result Summary of Sanitation Facilities

Type of Asset	SUB CITY	ID	No	No of Rooms	Area	Status	No
Communal Toilets	Ginbot 20	BD_LW_01	9	41	107.25	Functional	8
						Not Functional	1
	Tana	BD_LW_01	5	25	51.00	Functional	3
						Not Functional	2
	Hidar 11	BD_LW_01	6	34	78.00	Functional	6
						Not Functional	0
	Fasilo	BD_LW_01	8	32	66.25	Functional	8
						Not Functional	0
	Gish Abay	BD_LW_01	26	116	267.00	Functional	26
						Not Functional	0
	Sefene Selam	BD_LW_01	33	148	352.50	Functional	33
						Not Functional	0
	Shum Abo	BD_LW_01	19	78	204.45	Functional	18
						Under	1
		SUB TOTAL	**106**	**474**	**1,126.45**		
Public Toilet + Bath	Tana	BD_LW_01	1	6	66	Functional	1
						Not Functional	0
	Hidar 11	BD_LW_01	1	12	61	Functional	1
						Not Functional	0
		SUB TOTAL	**2**	**18**	**127**		

Source; Bahir Dar city municipality road asset management team

2.11 Vehicle pedestrian conflict analysis

"A traffic conflict is an observable situation in which two or more road users approach each other in space and time to such an extent that there is a risk of collision if their movements remain unchanged"*(*Aliaksei Laureshyn, Andras Varhelyi, 2018*)*. In many cases traffic problem are very hard to assess by crash studies since; sufficient time must pass to accumulate a meaning full crash history and many conditions show up only weakly not at all in crash statistics in spite of having a significant impact on traffic flow. Often the best way to assess these problems is by conflict analysis techniques. These techniques involve observing traffic and noting instances of apparent conflict, such as lane changing, brake application, or other erratic driving practices.

Traffic accidents are rare events and it takes a long time to collect a sufficient amount of accident data to produce reliable estimates of the expected number of accidents (Aliaksei Laureshyn and András Várhelyi, 2018). Conflict information is used to estimate crash potential at a location or to evaluate the impact of various operational changes. Many researchers feel conflict analysis allows assessment of safety without actually waiting for a long term historical record of crashes to occur. In addition, safety or impact of short term measures may be studied, even though no crashes may occur during the abbreviated implementation period (Traffic Engineering Manual, 2007).

The purpose of a conflict study is to identify hazardous locations and accident potentials so that these deficiencies may be eliminated before an accident occurs. This is especially important in accidents that involve pedestrians, which often result in an injury or fatality. Although less than 1 percent of all motor vehicle accidents involve pedestrians, approximately l8 percent of all fatality accidents in the United States are pedestrian accidents. This indicates that pedestrian accidents are more severe than the average accident. Because of this severity, a conflict technique needs to be developed that will identify hazardous locations and safety deficiencies and assist in the development of countermeasures to reduce or eliminate pedestrian accidents (Cyneck, M.J, 1980).

Pedestrians are vulnerable road users, and despite their limited representation in traffic events, pedestrian involved injuries and fatalities are overrepresented in traffic collisions. However, little is known about pedestrian exposure to the risk of collision, especially when compared to the amount of knowledge available for motorized traffic. More data and analysis is therefore required to understand the processes that involve pedestrians in collisions. Collision statistics alone are inadequate for the study of pedestrian vehicle collisions because of data quantity and quality issues.

Various conflict indicators have been developed to measure the severity of an interaction by quantifying the spatial and temporal proximity of two or more road users. The main advantage of conflict indicators is their ability to capture the severity of an interaction in an objective and quantitative way.

2.12 The concept of conflict severity

The proximity to a collision is the only one dimension or measure of "severity". The potential consequences in case a collision had taken place is another aspect that should be taken into account. For example, minor collisions between cars at parking lots are hardly any concern for road safety, as they almost never result in any injuries for car occupants. On the other hand, a near-miss between a pedestrian and a heavy truck moving at high speed would be perceived as a very severe situation as, had it become a collision, the consequences would be very dramatic (Aliaksei Laureshyn and András Várhelyi, 2018).

3. Research Methodology

3.1 Study area description

Bahir Dar's center city is found in the center of Bahir Dar Metropolitan City Administration. Astronomically, Bahir Dar city is located at the geographic co-ordinates of 11°38' north latitudes and 37°15' east longitudes. Bahir Dar City is found at the distances of 567 km along Addis Ababa – Dejen - Debre Markos- Bure road and 465 km along Addis Ababa –Dejen – Motta road. Its location at this spot favors the city with many and multi-faceted opportunities like water resources (Lake Tana and Abay River), suitable topography for transportation and other purpose, favorable climate to live, to serve as a center or capital city for Amhara region, Ethiopia and so on. The city has an estimated area of 16000 hectare. According to the 1996 master plan, the boundary of the city stretches up to Yibab Eyesus in the west, Abun Hara Digil in the east (along the lakeshore), Igir Ber and Kutatna plateau in the south (BDIDP, 2006).

Figure 3. 1 Map of Bahir Dar city (source; Google earth)

According to the Central Statistics Authority (CSA), the first national population and housing census was conducted in 1984 and counts the population of Bahir Dar City as 54,766. The second national population and housing census was conducted 10 year latter in 1994 shows that the total population of Bahir Dar city as 94,235. The projected growth rate is obtained from the

Central Statistical Authority (CSA) in its Annual Statistical Abstract of 2004 projects the total population size of 159,793 (Male 82,498 and Female 77,295) for the year 2005.

Table 3. 1 Bahir Dar city population growth rate (1984-2015)

Year	Growth rate	population
1984	-	54766
1994	5.4	94235
2005	5.3	168048
2010	5	215778
2015	5	277064

Source: Central Statistics Authority of Bahir Dar city

Different types of data are used to meet the objectives of this thesis. Among these questionnaires for pedestrians and cyclists to know their perception about challenges of walking and cycling, traffic volume and geometric data of selected road segments to determine pedestrian and cycle level of service, survey or study pedestrian vehicle conflicts to determine conflict severity by using video observation at different locations.

3.1 Research design

The cross sectional study design was applied in the study. In a cross sectional design the author decided on what the study needs to find out, identify the study population, select a sample from the study population and contact the respondents to obtain the information needed. This study design is best suited given its nature of taking a cross section of a study area one at a time. This study also adopted purposive sampling methods on key informants. This is a non-probability sampling technique method that would give the opportunity to select the sample based on key informants and focus group discussions.

3.2 Source of data

The different types and sources of data were required to support this study were identified. Consequently, in this study both primary and secondary data were needed to achieve the required objective. The primary data were collected by questionnaire, field observation/inspection, discussion and interviews (with representatives of the public/community, local authorities and

professionals), and secondary data were obtained from Bahir Dar police commission (pedestrian and Bicycle crash data), and different literatures were reviewed to get the required information.

3.3 Target population

The target population involved were the road users of the Bahir Dar city, which included road users (pedestrians), cyclists, motorists, transport officers, traffic polices, people working within the city or those traveling into and out of the center, students attending college and university and the users of various offices and establishments within the city of Bahir Dar.

3.4 Sampling method

The sample chosen for this study would be clustered and random sampling method. The clusters would be picked up at randomly given the concentration of users in the city of Bahir Dar transport system in the city of Bahir Dar. This study also adopted purposive sampling methods on key informants. This is a non-probability sampling techniques that would give the opportunity to select the sample based on key informants and focus group discussion.

3.5 Sample size determination for questionnaire

The most frequently asked question concerning determination of sampling is, "What size sample do I need?" The answer to this question is influenced by a number of factors, including the purpose of the study, population size, the risk of selecting a "bad" sample, and the allowable sampling error. In addition to the purpose of the study and population size, three criteria usually will need to be specified to determine the appropriate sample size: the level of precision, the level of confidence or risk, and the degree of variability in the attributes being measured. (Glenn D, 1992).

In the case target population is known we can determine the sample of the population by using the following formula,

$$n = \frac{N{Z_{\alpha/2}}^2 * P(1-P)}{e^2(N-1)+{Z_{\alpha/2}}^2 * p(1-P)}$$ ..... Equation *3.1*

(Ketkesone Phrasisombath, 2009)

Where

n = number of sample size

N= Total number of target population

p= estimate of allowable maximum variability = 0.5

e = acceptable margin of error for proportion being estimated 5% = 0.05 i.e. It considers that 20% variation in the population of Bahir Dar city

$Z_{\alpha/_2}{}^2$ = 1.96, which means a 95% confidence interval

3.6 Primary Data Collection System

This is the first hand information from field observation and the participants in the study area that were required to support the study. The methods employed in primary data collection system include; administering questionnaires, direct field observations/inspections and different field photographs, interviewing with key informants.

3.6.1 Questionnaires for pedestrians and cyclists;

Administering questionnaires were prepared in order to get enough information to assess the challenges and opportunities of non-motorized transport or cycling and walking in Bahir Dar city. Different parts of the city road users or peoples were participated in the questionnaire like students, merchants, teachers etc. and other more parts of the people. Different alternative choice and open ended questions are prepared to the road user of Bahir Dar especially for those pedestrians and cyclists.

The total number of passengers in the city of Bahir Dar is about 333570 passengers per day (source; Bahir Dar administration city transport office). Therefore, this number of road users can be taken as the target population to determine the sample size (considering the respondents as pedestrians and cyclists). By substituting the values that are assumed above, the required number of sample are 384 for pedestrians and cyclists. This is based on the number of sample sizes estimated based on the confidence level (level of certainty), the characteristics of the data collected will represent the characteristics of the total populations (95%) and margin of error that is the accuracy required for any estimates made from the sample (5%). However, for the factor of safety 10% of the questionnaires has been added and totally 425 questionnaires have been distributed. In addition to this respondents are selected from transport Engineers, spatial planners, traffic police officers, geo spatial Engineers and other concerned bodies to answer the questionnaire and interview.

3.6.2 Interviewing with key informants;

Personal interviews and discussions were done with key informants from relevant Bahir Dar city institutions and authorities such as offices of Bahir Dar municipality professionals, Bahir Dar city administration, and bureau of road and transport and traffic police commission commissioner. Therefore, the author got sufficient information about the challenges and opportunities of non-motorized transportation (cycling and walking) in Bahir Dar city.

3.6.3 Participatory transect walk and photographs;

Direct observations or field survey were the main source of primary data. Participatory transect walks for two to three weeks were undertaken to observe and document the current challenges and opportunities for using cycles and walk as a pedestrian and cyclists. Different photographs were taken to document the existing challenges and opportunities on the mobility facing the Bahir Dar city cyclists and pedestrians. The author also takes urban street measurements like sidewalk width, buffer width, outside through lane, obstruction width or presence of utility poles and trees etc. to determine effective width of sidewalk to determine pedestrian and Bicycle level of service.

3.6.4 Traffic counts;

The traffic count tallies were prepared and conducted at selected cordon stations or road sections within the Bahir Dar city to determine the level of motorized and non-motorized transport i.e. walking, cycling and others like hand cart and animal drawn carts which is used to transport different goods. The traffic count tally were done for four days (Monday, Wednesday Friday and Saturday) of total time taken 14 hours i.e. from morning 12:00 hour to evening 2:00 hour of which could be used to give representation on the volume of traffic on the city. The three major outlets radiating from the Bahir Dar city center towards Debre Markos, Motta, and Gondar are selected for the purpose of traffic count, because these roads represent the condition of traffic transport in Bahir Dar city. The selected routes are:

1. In the West direction i.e. at the entrance and exit of D/Markos to center of Bahir Dar city.
2. In the South direction i.e. at the entrance and exit of Motta to the center of Bahir Dar city.
3. In the North direction i.e. at the entrance and exit of Gondar to the center of Bahir Dar city.

3.7 Pedestrian and Bicycle level of service by using Highway Capacity Manual (HCM) 2010

3.7.1 Methodology for pedestrian level of service (LOS) determination

Highway Capacity Manual; is a collection of procedures and methodologies for calculating highway capacity and level of service. It provides methods for analyzing in advance the quantity of service a highway can provide as well as the quality of that service. Capacity and quality of service analysis have generated interest on an international scale. The HCM has been translated in to several languages, and research conducted in numerous countries outside of North America has contributed to the development of HCM methodologies (HCM, 2010). Highway capacity manual even less quantifiable but equally important benefits in the form of consistency, reliability, and recognized credibility and also more consistent from project to project from city to city and even among different countries (TR News, 1987). Urban street segment performance from a pedestrian perspective were evaluated separately for each side of the street or sidewalk. The methodology used for evaluating the performance of an urban street segment in terms of its level of service to pedestrians in the city of Bahir Dar for selected road section is given as follow.

- Determine free flow pedestrian walking speed,
- Determine average pedestrian space,
- Determine pedestrian delay at intersection,
- Determine pedestrian travel speed,
- Determine pedestrian LOS score for intersection,
- Determine pedestrian LOS score for link,
- Determine pedestrian LOS for link,
- Determine roadway crossing difficulty factor,
- Determine pedestrian LOS score for segment,
- Determine pedestrian LOS for segment,

1. Determine free flow walking speed

The average free flow pedestrian walking speed S_{pf} is needed for the evaluation of urban street segment performance from a perspective of pedestrian. Different research result indicates that average free flow pedestrian walking speed depends on age of pedestrians and grade or terrain of

the sidewalk. If 0% to 20% of pedestrians traveling along the road segment are elderly (i.e., 65 years of age or older), an average free-flow walking speed of 1.33 m/s (4.4 ft/s) is recommended for segment evaluation. If more than 20% of pedestrians are elderly, an average free-flow walking speed of 1 m/s (3.3 ft/s) is recommended. In addition, an upgrade of 10% or greater reduces walking speed by 0.091m/s (0.3 ft/s) (HCM 2015). By considering less than 20% of elderly pedestrians and flat terrain sidewalk, the average free flow pedestrian walking speed is selected as 1.33 m/s (4.4 ft/s).

2. Average pedestrian space

Average pedestrian space is an indicator of segment performance for travel in a sidewalk. It depends on the effective sidewalk width, pedestrian flow rate, and walking speed.

a) Effective sidewalk width

$W_E = W_T - W_{o,i} - W_{o,o} - W_{s,i} - W_{s,o} \geq 0$ ..... *Equation 3- 1*

$W_{s,i} = max(W_{buf}, 1.5)$ ..... *Equation 3- 2*

$W_{s,o} = 3p_{window} + 2p_{building} + 1.5p_{fence}$ ..... *Equation 3- 3*

$W_{o,i} = \omega_{o,i} - W_{s,i} \geq 0$ ..... *Equation 3- 4*

$W_{o,o} = \omega_{o.o} - W_{s,o} \geq 0$ ..... *Equation 3- 5*

Where

- W_E = effective sidewalk width (ft),
- W_T = total walkway width (ft),
- $W_{o,i}$ = adjusted fixed object effective width on inside of sidewalk (ft),
- $W_{o,o}$ = adjusted fixed object effective width on outside of sidewalk (ft),
- $W_{s,i}$ = shy distance on inside (curb side) of sidewalk (ft),
- $W_{s,o}$ = shy distance on outside of sidewalk (ft),
- W_{buf} = buffer width between roadway and sidewalk (ft),
- p_{window} = proportion of sidewalk length adjacent to a window display (decimal),
- $p_{building}$ = proportion of sidewalk length adjacent to a building face (decimal),
- p_{fence} = proportion of sidewalk length adjacent to a fence or low wall (decimal),
- $\boldsymbol{\omega}_{o,i}$ = effective width of fixed objects on inside of sidewalk (ft),
- $\boldsymbol{\omega}_{o,o}$ = effective width of fixed objects on outside of sidewalk (ft),

b) Pedestrian flow rate per unit width

$V_p = \frac{V_{ped}}{60W_E}$ ..... Equation 3- 6

Where

V_p = pedestrian flow per unit width (p/ft/min),

V_{ped} = pedestrian flow rate in the subject sidewalk (walking in both directions) (p/h) and,

W_E = effective sidewalk width (ft)

c) Average walking speed

$S_p = (1 - 0.00078{V_p}^2)S_{pf} \geq 0.5S_{pf}$ ..... Equation 3- 7

Where,

S_p = pedestrian walking speed (ft/s),

S_{pf} = pedestrian free flow walking speed (ft/s),

V_p = pedestrian flow per unit width (p/ft/min).

d) Pedestrian space

$A_p = \frac{60*S_p}{V_p}$ ..... Equation 3- 8

Where,

A_p = pedestrian space (ft^2/p)

Table 3. 2 Qualitative description of pedestrian space

Pedestrian space (ft^2/p)	Description
>60	Ability to move in desired path, no need to alter movement
>40-60	Occasional need to adjust path to avoid conflicts
>24-40	Frequent need to adjust path to avoid conflicts
>15-24	Speed and ability to pass slower pedestrians restricted
>8-15	Speed restricted, very limited ability to pass slower pedestrians
<=8	Speed severely restricted, frequent contact with other users

Source HCM 2015 exhibit 18-24

3. Pedestrian delay at intersection

Pedestrian delay to cross Major Street

$d_p = \frac{(C-g_{walk,mi})^2}{2C}$ ..... Equation 3- 9

Where,

d_p = pedestrian delay (s/p),

$g_{walk, mi}$ = effective walk time for the phase serving the minor street through movement (s),

C = Cycle length (s).

Delay variable represents the delay incurred by pedestrians who;

- Travel through boundary intersection along a path that is parallel to the segment centerline (d_{pp}),
- Cross the segment at the nearest signal controlled crossing (d_{pc}),
- Waiting a gap to cross the segment at uncontrolled location (d_{pw}),

4. Pedestrian travel speed

$S_{TP,seg} = \frac{L}{\frac{L}{S_p}+d_{pp}}$ ..... Equation 3- 10

Where,

$S_{Tp, seg}$ = travel speed of through pedestrians for the segment (ft/s)

L = segment length (ft),

S_p = pedestrian walking speed (ft/s),

Dpp = pedestrian delay when walking parallel to the segment (s/p),

5. Pedestrian LOS score for intersection

$I_{p,int} = 0.5997 + F_w + F_v + F_s + F_{delay}$ ..... Equation 3- 11

$F_w = 0.681 * (N_d)^{0.514}$ ..... Equation 3- 12

$F_v = 0.00569\left(\frac{v_{rtor}+v_{lt,perm}}{4}\right) - N_{rtci,d}(0.0027n_{15,mj} - 0.1946)$ ..... Equation 3- 13

$F_s = 0.00013n_{15,mj}S_{85,mj}$ ..... Equation 3- 14

$F_{delay} = 0.0401ln(d_{p,d})$ ..... Equation 3- 15

$n_{15,mj} = \frac{0.25}{N_d}\sum vi$ ..... Equation 3- 16

Where,

$I_{p, int}$ = pedestrian LOS score for intersection,

F_w = cross section adjustment factor,

F_v = motorized vehicle volume adjustment factor,

F_s = motorized vehicle speed adjustment factor,

F_{delay} = pedestrian delay adjustment factor,

N_d = number of traffic lanes crossed when traversing crosswalk D (ln)

$N_{rtci.d}$ = number of right turn channelizing islands along crosswalk D,

$n_{15, mj}$ = count of vehicles travelling on the major street during a 15 min period (veh/ ln),

$S_{85, mj}$ = 85^{th} percentile speed at mid segment location on the major street (mi/hr),

$D_{p,d}$ = pedestrian delay when traversing crosswalk D (s/p),

v_i = demand flow rate for movement i (veh/hr), and

m_d = set of all automobile movements that cross crosswalk D

6. Pedestrian LOS score for link

$$I_{p,link} = 6.0468 + F_w + F_v + F_s \quad \text{Equation 3- 17}$$

$$F_w = -1.2276ln(W_v + 0.5W_1 + 50P_{pk} + W_{buf}f_b + W_{aA}f_{sw}) \quad \text{Equation 3- 18}$$

$$F_v = \frac{0.0091v_m}{4N_{th}} \quad \text{Equation 3- 19}$$

$$F_s = 4(\frac{S_R}{100})^2 \quad \text{Equation 3- 20}$$

Where,

$I_{p, link}$ = pedestrian LOS for link,

F_w = cross-section adjustment factor,

F_v = motorized vehicle volume adjustment factor,

F_s = motorized vehicle speed adjustment factor,

W_1 = effective width of combined bicycle lane and shoulder (ft),

W_v = effective total width of outside through lane, Bicycle lane and shoulder as a function of traffic volume (ft),

W_{buf} = buffer width between roadway and available sidewalk (=0 if sidewalk is not available) (ft)

P_{pk} = proportion of no-street parking occupied (decimal),

f_b = buffer area coefficient,

W_A = available sidewalk width = if sidewalk doesn't exist or (W_T - W_{buf}) if sidewalk exists (ft),

W_{aA} = adjusted available sidewalk width = min (W_A, 10) (ft),

f_{sw} = sidewalk width coefficient = 6 - 0.3W_{aA},

v_m = mid segment demand flow rate (direction nearest to the subject sidewalk) (veh/h),

N_{th} = number of through lanes on the segment in the subject direction of travel (ln), and

S_R = motorized vehicle running speed = (3600L)/5280t_R) (mi/h),

7. Determine link LOS

8. Roadway crossing difficulty factor

A. Diversion delay

$D_d = 2D_c$ ..... Equation 3- 21

Dd = diversion distance (ft),

Dc = distance to nearest signal control crossing (ft),

$d_{pd} = \frac{D_d}{S_p} + d_{pc}$ ..... Equation 3- 22

Where,

d_{pd} = pedestrian diversion delay (s/p),

D_d = diversion distance (ft),

S_p = pedestrian walking speed (ft/s),

d_{pc} = pedestrian delay when crossing the segment at the nearest signal controlled crossing (s/p),

B. roadway crossing difficulty factor

$F_{cd} = 1 + \frac{0.1d_{px} - (0.318\, I_{p,link} + 0.220\, I_{p,int} + 1.606)}{7.5}$ ..... Equation 3- 23

Where,

F_{cd} = roadway crossing difficulty factor,

d_{px} = crossing delay = min(d_{pd}, d_{pw}, 60) (s/p),

d_{pd} = pedestrian diversion delay (s/p),

d_{pw} = pedestrian waiting delay (s/p),

$I_{p,\,link}$ = pedestrian LOS score for link, and

$I_{p,\,int}$ = pedestrian LOS score for intersection.

9. Pedestrian LOS score for segment

$I_{p,seg} = F_{cd}(0.318\, I_{p,link} + 0.220\, I_{p,int} + 1.606)$ ..... Equation 3- 24

Where,

$I_{p,\,link}$ = pedestrian LOS score for the segment

10. Determine segment LOS

3.7.1 Methodology for Bicycle level of service (LOS) determination

Methodology used for evaluating the performance of an urban street segment in terms of its level of service to Bicyclists at the selected road section of Bahir Dar city were determined by the following procedure,

- Determine Bicycle running speed,
- Determine Bicycle delay at intersection,
- Determine Bicycle travel speed,
- Determine Bicycle LOS score for intersection,
- Determine Bicycle LOS score for link,
- Determine Bicycle LOS for link,
- Determine Bicycle LOS score for segment,
- Determine Bicycle LOS for segment,

1) Bicycle running speed

An average running speed S_p is determined as either in the field or recommended 15mi/hr in HCM 2015 manual.

2) Bicycle delay at the intersection

This delay is incurred by Bicyclists who travel through the intersection in the same lane as segment through vehicles.

$$d_b = \frac{0.5C(1-g_b/C)^2}{1-min\left[\frac{v_{bic}}{c_b},1\right]\frac{g_b}{C}}$$ ..... Equation 3- 25

$$C_b = s_b \frac{g_b}{C}$$ ..... Equation 3- 26

Where,

d_b = Bicycle delay (s/bicycle),

v_{bic} = Bicycle flow rate (Bicycles/ h),

g_b = effective green time for Bicycle lane (s),

C = cycle length (s),

c_b = capacity of the Bicycle lane (Bicycles/h)

s_b = Saturation flow rate of the Bicycle lane = 2000 (Bicycles/hr)

3) Bicycle travel speed

$$S_{Tb,seg} = \frac{3600L}{5280(t_{Rb}+d_b)}$$ ..... Equation 3- 27

Where,

$S_{Tb, seg}$ = travel speed of through Bicycles along the segment (mi/h),

L = length of segment (ft),

T_{Rb} = segment running time of through Bicycles = (3600L)/(5280S_b) (s),

d_b = bicycle control delay (s/bicycle),

S_b = Bicycle running speed (mi/h),

4) Bicycle LOS score for intersection

$I_{b,int} = 4.1324 + F_w + F_v$ ..... Equation 3- 28

$F_w = 0.0153W_{cd} + 0.2144W_t$ ..... Equation 3- 29

$F_v = 0.0066\frac{v_{lt}+v_{th}+v_{rt}}{4N_{th}}$ ..... Equation 3- 30

$W_t = W_{ol} + W_{bl} + I_{pk}W_{os}$ * ..... Equation 3- 31

Where,

$I_{b, int}$ = Bicycle LOS score for intersection,

W_{cd} = curb to curb width of the cross street (ft),

W_t = total width of the outside through lane, Bicycle lane, and paved shoulder (ft),

v_{lt} = left turn demand flow rate (veh/h)

v_{th} = through demand flow rate (veh/h),

vrt = right turn demand flow rate (veh/h),

N_{th} = number of through lanes (shared or exclusive) (ln),

W_{ol} = width of outside through lane (ft),

W_{bl} = width of the Bicycle lane = 0 if Bicycle not provided (ft),

I_{pk} = indicator variable for on street parking occupancy = 0 if p_{pk} >0, or 1 otherwise,

P_{pk} = proportion of on street parking occupied (decimal),

W_{os} = width of paved outside shoulder (ft), and

W_{os}^* = adjusted width of paved outside shoulder, if if curb is present W_{os}^* = W_{os} – 1.5 ≥ 0 otherwise, W_{os}^* = W_{os}

5) Bicycle LOS score for link

$I_{b,link} = 0.76 + F_w + F_v + F_s + F_p$ ..... Equation 3- 32

$F_w = -0.005W_e^2$ ..... Equation 3- 33

$F_v = 0.507ln(\frac{v_{ma}}{4N_{th}})$ ..... Equation 3- 34

$F_s = 0.199[1.1199ln(S_{Ra} - 20) + 0.8103](1 + 0.1038P_{Hva})^2$ ..... Equation 3- 35

$F_p = \frac{7.066}{P_c^2}$ ..... Equation 3- 36

Where,

$I_{b, link}$ = Bicycle LOS score for link,

F_w = cross-section adjustment factor,

F_v = motorized vehicle volume adjustment factor,

F_s = motorized vehicle speed adjustment factor,

F_p = pavement condition adjustment factor,

W_e = effective width of outside through lane (ft),

v_{ma} = adjusted midsegment demand flow rate (veh/h),

N_{th} = number of through lane on the segment in the subject direction of travel (ln),

S_{Ra} = adjusted motorized vehicle running speed (mi/h),

P_{Hva} = adjusted percent heavy vehicles in midsegment demand flow rate (%) and,

P_c = pavement condition rating

6) **Determine link LOS**

7) **Bicycle LOS score for segment**

$I_{b,seg} = 0.16I_{b,link} + 0.011F_{bi}e^{I_{b,int}} + 0.035\frac{N_{ap,s}}{(L/5280)} + 2.85$ ..... Equation 3- 37

Where,

$I_{b, seg}$ = bicycle LOS score for segment,

$I_{b, link}$ = bicycle LOS score for link,

F_{bi} = indicator variable for boundary intersection control type =1 if signalized, 0 if two way stop control,

$I_{b, int}$ = bicycle LOS score for intersection and,

$N_{ap, s}$ = number of access point approaches on the right side in the subject direction of travel (points),

8) **Determine Bicycle segment LOS**

3.8 Pedestrian vehicle Conflict analysis

Pedestrian Walking is a key non-motorized mode of transport that connects different components of a multimodal transport network and interfaces with external activity areas (land use). Building safe and walking-friendly pedestrian facilities is fundamental to encouraging and accommodating walking activities. Traffic vehicle pedestrian conflicts are a measure of the potential for traffic accidents. The purpose of a pedestrian vehicle conflict study is to identify hazardous locations and accident potentials so that these deficiencies may be eliminated before an accident occurs.

Types of pedestrian vehicle conflicts that will be collected on the selected route sections are,

- Pedestrian walking conflict (PW),
- Running pedestrian conflict (PR),
- Pedestrian walking or running in the roadway with the flow of traffic (WF),
- Pedestrian walking or running in the roadway against the flow of traffic conflict (AF),
- A diagonal pedestrian crossing conflict (PD),
- Outside crosswalk conflicts (OC),
- Right turning conflicts (VR),
- Left turning conflicts (VL),
- Right turn on red conflicts (RR),
- Signal change conflicts (SC),
- Pedestrian violation conflict (PV),
- Vehicle violation conflict (VV),
- Pedestrian in center line (CL),

Conflict studies can be conducted at selected intersections or at midblock locations, such as midblock crossings in the central business district (CBD) or shopping areas and other sites where a hazardous pedestrian problem exist.

Pedestrian conflicts were counted on Tuesday, Wednesday, Thursday and Saturday for selected locations. Data were collected for an interval of 2 -4 hrs including peak and off peak times for each selected day.

Conflict severity can be measured by observing the actions of the pedestrian or vehicle during the occurrence of conflict. The following were the list of pedestrian actions that can be used to measure conflict severity.

- Hesitation
- Backup movement
- Running movement
- Near miss accident
- Property damage only (PDO) accident
- Injury accident
- Fatality

Conflict severity can also evaluated by observing the action of the vehicle involved in the conflict. Vehicle actions given below are measure of severity

- Routine conflict
- Complete stop or erratic maneuvers
- Near miss accident
- Property only damage (POD) accident
- Injury accident
- Fatality accident

Three levels of conflict severity

1) Minor conflict; was observed as moving vehicle conflict where a hazardous situation exists but no actual weaving or braking takes place.
2) Moderate conflict; was identified by considering a routine conflict and complete stop or erratic maneuver conflicts. Therefore, a moderate conflict is when a braking or weaving action is taken by a vehicle to avoid a collision with a pedestrian.
3) Sever conflict; which was identified as a near miss accident

Conflict data form

1 Observer_____ Date_____

2 Location; city_____

Street name_____

Name of nearest intersecting street_____

Distance to nearest intersection_____

3 Weather conditions; a) clear/cloudy b) rain c) snow/sleet d) fog e) any other_____

4 Roadway condition; a) dry b) wet c) snow/ice/mud d) any other_____

5 Type of roadway; a) one way b) two way c) divided d) any other_____

6 posted speed _____

7 Environment a) residential area b) commercial area c) industrial area d) school e) any other _____

Table 3. 3 format for vehicle pedestrian conflict severity

Starting time	severity	PW	PR	WF	AF	PD	OC	VR	VL	RR	SC	PV	VV	CL

	Minor													
	Moderate													
	Sever													
	Minor													
	Moderate													
	Sever													

3.9 Secondary source of data

The secondary data were obtained mainly through literature review of the existing work by academicians and researchers on Non-Motorized transport, and crash data from traffic police commission commissioner. Other sources of secondary data were included university libraries, internet, Bahir Dar city municipality different documents, Bahir Dar city administration documents, Bahir Dar integrated Development plans, Bahir Dar city road and transport sector and government documents on transport and environment of the city.

3.10 Data Analysis and Interpretation

The collected data from field was viewed and edited to ascertain its suitability and required accuracy. The methodology of the study was based on quantitative and qualitative data analysis. These methods vary from simple summations and percentages to statistical analysis like ch-square test of association and correlation and significance of different variables on challenges and opportunities of non-motorized transport. The quantitative data was analyzed using descriptive statistics and presented in the form of graphs, tables, percentages and charts. The qualitative data was analyzed through the use of content analysis of the questions administered with reference to the study or specific objectives. Results of both quantitative and qualitative data analysis were provided information that forms the basis for discussion, conclusion, and interpretation of the findings and recommendations of the study.

Ms excel and Statistical Packet for Social Sciences (SPSS) would be used for the analysis (graphs, tables, percentages, and significance of variables) of the collected data.

4. Results and Discussion

4.1 Introduction

The data that were collected by administering questionnaires, direct field observation, interviewing key informants, participatory transect walk and field photographs, and data from secondary sources are presented and discussed in this chapter. And also, the response rate, the socio-economic characteristics, time taken during the trip, purpose of the journey, modal choice transport, level of education, non-motorized transport facilities, traffic count tally locations are analyzed in this chapter.

4.2 Response rate

Table 4. 1 The number of questionnaire and respondents response rate

Response rate	frequency	Percentage (%)
Response	425	100
No response	0	0
Total	425	100

Source; result of author's questionnaire survey

As indicated in the table the respondents' response rate on all the questionnaire were 100% with more than 80% of the questions are answered. This high number of response rate will be entirely used to the fact that the questions were administered directly to the respondent by the researcher and research assistants and thus no one was left with any of the questionnaires to be filled at a later date.

4.3 Demographic of respondent

Table 4. 2 Demographics of respondent

Demographic	Response	
	Frequency	Percentage (%)
Gender		
Male	301	71.7
Female	119	28.3
Age		
Below 18 years	24	5.65
18-36 years	338	79.53
37-55 years	55	12.94
Above 55 years	8	1.88
Level of education		
No formal education	2	0.5
1st level education	49	11.6
2nd level education	94	22.3
College level & Poly technic	83	19.7
University level	194	45.9
Occupation		
Employer	199	46.8
Private work	149	35.1
Daily labor	21	4.9
Student	56	13.2

Source; result of author's questionnaire survey

It has been observed that people of different age groups were participated in the study area. Respondents according to age group calculated as below 18 years 24(5.65%), [18 – 36] years 338(79.53%), [37 – 55] years 55(12.94%), and above 55 years 8(1.88%). From the age bracket of the respondents rate it can be observed that the middle age group is mainly participated in both motorized and non-motorized transport operations. The table further gives that 92.47% of the respondents fall under the age group between [18 – 55] years, are mainly engaging in different work activities.

From the table among the travelers participated only 0.5% of the respondents had no formal education while most respondents are 1st level education 49(11.6%), 2nd level education 94(22.3%), poly technic and college level 83(19.7%) and university level 194(45.9%). Whether the traveler uses motorized or non-motorized transport most respondents are educated.

From the respondents occupation most of the people are employer 199(46.8%) either in governmental or private companies, offices etc. and private workers 149(35.1%) while 21(4.9%) and 56(13.2%) were daily laborers and students respectively. Therefore, non-motorized facilities like Bicycle lane and End of trip bicycle facilities (bicycle storage racks or lockers, showers, and clothes changing facilities) and pedestrian walkway and its facility are provided at its work area, more peoples can use non-motorized transports as their main preferred mode of transport.

4.4 Questionnaire about mode of transport and satisfaction by the time taken

What is your preferred mode of transport in Bahir Dar city?

Table 4. 3 Preferred mode of transport

Mode type	Number of users	Percentage (%)
Bajaj	74	17.4
Public transport	45	10.6
Walking	171	40.2
Bicycle	119	28.0
Other (M. cycle & Private car)	16	3.8
Total	425	100

Source; result of author's questionnaire survey

When the facilities of non-motorized transport (cycling and walking) are fulfilled partially or fully most people are preferred to use walking and cycle as their major mode of transport.

Which mode of transport is mostly available or do you used in Bahir Dar city?

Walkers and bicyclists are highly motivated by exercise and enjoyment. Some utilitarian walking appears to be motivated by its relative convenience to other options. This is especially true for short errands/trips, particularly in CBDs and other high density districts.

Table 4. 4 Mostly available/used Modal share of passengers transport system in Bahir Dar city

Mode type	Number of users	Percentage (%)
Bajaj	212	49.9

Public transport	86	20.2
Walking	60	14.1
Bicycle	44	10.4
Other (M. cycle & Private car)	23	5.4
Total	425	100

Source; result of author's questionnaire survey

As data obtained from the questionnaire in Bahir Dar city, most people are using Bajaj to their means of transport mode. 49.9% of the people/respondent are using Bajaj to the transport of from their origin (home or residential area) to their destination i.e. work, shopping, recreation and social life and to school. The reason why most people use Bajaj as their mode of transport is given by easily availability of at any place and time.

These conventional mode selections is based on that peoples most use of their transport system. That means passengers that select Bajaj, public transport, or other mode of transport, are used walking as transport to move to and from work, recreation/social life, shopping/marketing, and school as a complement of their transport needs. Many of these shorter trips are linked by walking to longer trips, including a series of automobile trips to multiple destinations when running errands, walking to and from transit stops, and walking a few blocks to and from a parked car.

What is the purpose of your journey?

Table 4. 5 Purpose of the journey

Purpose of journey	Frequency	Percentage (%)
Work	298	70.1
Education	78	18.4
Shopping and business	17	4.0
Recreation & social life	32	7.5
Total	425	100

Source; result of author's questionnaire survey

In terms of trip purpose, road user trips are fairly diverse, but tend to concentrated on work, education, shopping and business, recreation and social life. From the study results it can be seen that most of passengers are go to work 298(70.1%) and some are for educational 78(18.4%)

purposes. When we say work, it includes governmental employers, self-employers, force laborers, and people who are engaged to get money to fulfill their basic needs. In the city there are a number of education centers like 4 kindergarten, 16 primary schools, 6 secondary schools, Bahir Dar TVET College and university of all campus. These are school destinations and accommodate a lot of students in each school. Therefore, providing non-motorized transport facilities or infrastructures and parking facilities in this area is important to encourage pedestrians and Bicyclists.

What is the reason to select your mostly used mode of transport in Bahir Dar city?

Table 4. 6 Reasons for selection of any mode of transport

Cause for mode selection	Frequency	Percentage (%)
Easily available	225	52.9
Cheap cost	63	14.8
Takes less time	79	18.6
Safety	58	13.6
Total	425	100

Source; result of author's questionnaire survey

From the table above we conclude that when transport modes are easily available and costs are fair passengers are willing to use the available transport mode. In general 225(52.9%) of all road users are used the transport mode of which is easily available and 79(18.6%), 63(14.8%) and 58(13.6%) are used where the journey takes less time, cost is cheap and more safe respectively.

How long do you take (minutes) to reach your destination?

Table 4. 7 Time taken from origin to destination

Time (min)	Frequency	Percentage (%)
1-20	248	58.4
21-40	89	20.9
41-60	66	15.5
>60	22	5.2
Total	425	100

Source; result of author's questionnaire survey

Distance and travel time is the most widely identified factor for not walking or cycling. Whether the passengers are used Bajaj, Public transport, Walking, Bicycle, and other mode of transport 248(58.4%) of trips are within the time range of [1-20] minutes to reach from their origin to destination. The average speed of pedestrian is 1.2m/s or 4.32km/hr. therefore, the maximum

distance that most pedestrian walk with the time range of [1-20] is 1.44km. And if we consider the maximum time 60 minutes, the distance will range up to 4.32km.

Are you satisfied by the time taken to reach your destination?

Table 4. 8 Satisfaction with the time taken

Satisfaction	Frequency	Percentage (%)
Satisfied	180	42.6
Unsatisfied	243	57.4
Total	423	100

Source; result of author's questionnaire survey

The table above presents the level of satisfaction with the time taken to reach from passengers/pedestrians origin to destination. Even if the distance travelled is short or the time taken is less, more of the respondents 243(57.4%) were not satisfied with the time taken to reach their destination. They listed a number of problems like traffic congestion, lack of Bicycle lane, shortage of pedestrian road facilities like sidewalk, zebra crossing and presence sidewalk is occupied by Illegal Street vendors and construction materials, long queue at the terminal of Bajaj and Taxi, poor road quality, lack of clear transport policy on NMT and Mvs are among others. 180(42.6%) of the respondents were satisfied with the time taken to reach their destination.

Reasons why the passengers are unsatisfied by different mode of transport (open ended question)

Reasons why the passengers are unsatisfied by different mode of transport have to be seen in to road facility problem, driver problem, congestion and traffic accident problem.

Road facility problems; modernized traffic flow and standard road should be available in the transport of Bahir Dar city. In most Bahir Dar cities i.e. primary, secondary and tertiary roads have not toilet and people use road sides to excrete and make bad smell that initiate pedestrians not to walk. Lack of wide side walk, sufficient zebra crossing, road marking and traffic signs, speed reducing mechanisms like hump. The main difficulty for the riders of Bicycle is no availability dedicated Bicycle lanes in the Bahir Dar city. Bicyclists are driving their Bicycle in the road with congested different vehicles and with a large number of pedestrians. Absence of standard road construction and pedestrian sidewalk facilities makes cyclists difficult to move due to presence of pedestrians and congestion due to large number of Bajaj.

Driver problems; There are drivers that are not disciplined and increase the cost of travel or fare and also ignore to give service unless otherwise contract. Taxis are carrying beyond their capacity. Some taxis are not work on their assigned rout location rather they want to work on contract in order to get more money. In the transport of taxi there is no respection for elders and disable peoples.

Congestion; at the morning and evening primary roads are very congested due to a lot of vehicles especially Bajaj, pedestrians and to some extent cyclists move from their origin to destination. In addition to these, illegal street vendors are move here and there to sell their commodity on the sidewalk. Most Pedestrian walkways are occupied by illegal street vendors and pedestrians are forced to walk into the vehicles lane. This is the cause for sever traffic accident and pedestrian congestion. Motor cycle and private car users are unsatisfied due congestion and absence of qualified or safe and standard roads. In the city there are a large number of Bajaj transport facilities and these are the main cause for congestion. Drivers have not respect the laws and regulation of traffic; that makes passengers face an accident. Some taxis are old or out of their design life and they are not move as expected of their speed. The time it takes to reach its destination is longer due to it stops in a number of spot points to the individual passenger.

Accident; traffic accidents are the most danger factor in Bahir Dar city due to un separated sidewalks and mixed movement of pedestrians with vehicles. At the time of morning and evening, Taxis are carrying beyond their capacity. Therefore, this makes passengers uncomfortable and increases the chance of sever accident.

Proposed solutions

- Provide meter taxi to avoid unnecessary costs on road users,
- Provide enough number of urban public buses should be increased to handle the increased number of urban population passenger,
- Sufficient number of Traffic polices should be available on the road and control illegal behavior of driver,
- To avoid the delay due to traffic congestion taxi drivers are better to use alternative routes,

- Drivers and passengers should get education by the concerned body to respect elders and disable peoples,
- To avoid congestion and delay it is better to decrease the number of Bajaj and increase the number and availability of public transport (Buses and Taxi) as well as increase the quality the service,
- To improve the walking condition of pedestrian, the city must provide quality road facilities like wide pedestrian lane, enough road crossing places or zebra crossing, and safe pedestrian environment.
- Increase the awareness of the people to the health, economic and safety advantage of walking,
- Manage Illegal street vendors, make them legal and give them right market place for buying and selling,
- As a short term solution give awareness for cyclists to use secondary and tertiary roads instead of primary roads. This is safe and reduces congestion and traffic accident due to fast moving vehicles.
- Transport planners and concerned body should consider the design of Bicycle lane in the city of Bahir Dar,
- Aware Vehicle drivers to give priority for pedestrians, drive with lower design speed at the place where high numbers of pedestrians are present.
- encourage more people to use walking as a mode of transport by providing enough wide side walk, sufficient zebra crossing, road marking and traffic signs, speed reducing mechanisms like hump,

4.5 The conditions of non-motorized transport infrastructures, crossings and challenges

How would you describe Presence and quality of pedestrian walkway/sidewalk width rating in Bahir Dar city?

Improving Road Street lighting at pedestrian crossing and raising the pedestrian crosswalks is very important to the safety of pedestrians. According to author's observation the existing pedestrian walkway width is found in a good condition especially, recently constructed roads have sufficient walkway width. But most pedestrian walkway that constructed before is occupied

by many obstacles like illegal street vendors, by construction materials, utility poles and shoeshine boy. For instance, the part of sidewalk that is found from Papyrus hotel to St. Georges, is occupied by shoeshine boys and illegal street vendors.

Table 4. 9 presence and quality of pedestrian sidewalk width

Rating	Frequency	Percentage (%)
Excellent	21	5.0
Good	89	21.2
Satisfactory	174	41.5
Poor	135	32.3
Total	419	100

Source; result of author's questionnaire survey

Improving provision for pedestrian sidewalk will help to maintain the currently high modal share of walking with in the city and help to discourage a shift towards travels by private motorized vehicle. Sidewalks are designed primarily to allow safe pedestrian movement separated from moving traffic and facilitate the use of public transit from one mode of transport to another. According to the respondents rate the quality of pedestrian walkway in the city of Bahir Dar is more of satisfactory 174(41.5%), poor 135(32.3%) and good 89(21.2%). There are also very few respondents who say excellent 21(5.0%) quality of pedestrian sidewalk. In general the existing pedestrian side walk is found in a poor condition.

Figure 4. 1 problems of pedestrian due to absence of sidewalk

One of the features of the pedestrian travel environment in Bahir Dar city is the existence of mixed traffic where pedestrians, Bicyclists and vehicles share the same road space, with no or very few facilities for pedestrians or cyclists.

One of the active transport systems or non-motorized transport systems pedestrian walking accounts the highest number. According to the data obtained from Bahir Dar city road transport office (2016/17), there are about 2,334,990 residential passengers per week or 333,570 residential passengers per day are expected to move with kilo meter coverage of 2378756.4 km per week or 339822.4 km per day. Among these data, most passengers are pedestrians who walk weather the presence of sidewalks/ walkways or at the absence of pedestrian facilities. When we observe the facility of the pedestrian walkway in Bahir Dar city it is very poor. According to the survey of Bahir Dar city municipality road asset management team, there is only 77.54 km pedestrian walkway or side walk total length within the city. The table below shows the survey result of team group in terms of road type i.e. Asphalt, Precast Paving Block, Cobble stone etc.

Table 4. 10 Summary Information for Pedestrian Walkways

Type of Pedestrian Walkway	Primary	Secondary	Local Road and	Total(KM)
Asphalt	3.13	0.24	0.39	**3.76**
Precast Paving Block	2.64	4.9	1.83	**9.37**
Cobble Stone	0.53	1.12	1.23	**2.88**
Concrete	3.6	0.3	0.3	**4.2**
Gravel	1.004	0.1	0.06	**1.164**
Red Ash	2.1	0.41	0.41	**2.92**
Terrazzo/Clay Tile	36.9	6.6	9.41	**52.91**
Earth	0.27	0	0.072	**0.34**
Total	**51.6771**	**10.32**	**23.5189**	**77.54**

Source; Bahir Dar city municipality road asset management team

How would you describe the quality of traffic signs, lights, road marking and pedestrian zebra crossing?

A pedestrian crossing is a point where pedestrians traverse the road. Pedestrian crossings, sometimes referred to as cross walks, may be found at intersections or along road stretches. Marked crossings are designated on the road, commonly white stripes (WHO, 2013). Roadway signs are symbols rather than words to convey and transfer their message. Symbols provide instant communication with roadway users or drivers and pedestrians, overcome language barriers or transfer the same information for all road users regardless of their language, and are

becoming standard for traffic control devices throughout the world. So, the presence of these traffic signs in the city of Bahir Dar is found in the poor condition or not found at the required place.

Table 4. 11 quality of traffic signs, lights, road marking and zebra crossing

Rating	Frequency	Percentage (%)
Excellent	27	6.5
Good	71	16.9
Satisfactory	158	37.7
Poor	163	38.8
Total	419	100

Source; result of author's questionnaire survey

Zebra crossings are one of the most common pedestrian safety countermeasures in the city of Bahir Dar and Ethiopia as a whole. It makes the more pedestrian to cross the road at a specific road section or painted Zebra crossing. The visibility of Zebra crossing or the presence of road marking in the city of Bahir Dar is more of in the poor condition. But, according to the respondents response rate the quality of traffic sign, lights, road marking, and zebra crossing visibility is poor 163(38.8%), satisfactory 158(37.7%), good 71(16.9%) and excellent 27(6.5%). In addition to the respondents' response, the researcher also made site visit at the main roads of the Bahir Dar city. According to the observation most crossing places have not visible road marking or Zebra crossing. Poor provision of Zebra crossing points on pedestrian and cyclists desire lines leads to a high level of informal crossing movements, some pedestrians are even seen vaulting guard railing to cross informally. Pedestrians cross one or more roads at some point in their journey, whether at an intersection or not. In many situations, crossing the road increases their risk of traffic injury.

Rank the following problems in their order of priority in terms of their endangering pedestrian safety?

Table 4. 12 Driver problems on pedestrian safety

No	Driver problems on pedestrian safety	frequency	Percentage (%)
1	Drive with over speed	106	36.3
2	Not give priority for pedestrians	153	52.4
3	No enforcement on drivers that violate traffic laws	22	7.5
4	Absence of number of pedestrian crossing (Zebra crossing)	11	3.8

	Total	292	100

Source; result of author's questionnaire survey

Awareness of all drivers on the safety of non-motorized transport is very important to initiate peoples to walk and cycle more. But, most drivers have not accepted the rules and regulation of traffic and rights of pedestrian. Due to these most people preferred to use other motorized mode of transport rather than to walk. By considering the problem of driver on pedestrian safety; not giving priority for pedestrian, over speed, not penalize drivers that violate traffic law and less number of marked pedestrian crossing is found as 52.4%, 36.3%, 7.5%, and 3.8% respectively as a result of pedestrians response. The concerned body should work hard on drivers' awareness to give priority for pedestrian and drive on a limited speed. And also give proper penalty for those drivers that violate the traffic law.

What type of sidewalk obstacles do you get frequently in the city of Bahir Dar?

Table 4. 13 Pedestrian obstacles on sidewalk

Sidewalk obstacles	frequency	Percentage (%)
Utility poles	20	4.7
Construction material	138	32.6
Illegal street vendors	193	45.7
Destructed road	72	17.1
Total	423	100

Source; result of author's questionnaire survey

Figure 4. 2 obstacles of pedestrian due to illegal street vendors

Figure 4. 3 obstacles of pedestrians due to construction materials on the sidewalk

Heavily obstructed sidewalks or lack of sidewalks, very poor visibility at night, the absence of any traffic calming measures, the lack of traffic lights particularly for right turning vehicles, and the high traffic speeds also contribute to extremely unsafe conditions which inhabit travel the movement of non-motorized transport (NMT). Sidewalk obstructions, such as loading vehicles, street sellers, retailers and building materials narrow the effective width and lead pedestrians to walk in the carriageway.

As it is known the number of sidewalk facilities in the city of Bahir Dar is limited. Especially around the center of the city or CBD of the city the sidewalk is very narrow since a large number of passengers are used these narrow road and different work activities are under taken here. In addition to these problems, there are also a number of obstacles that present on the road. These obstacles are illegal street vendors, construction materials, destructed road and utility pole that occupy the pedestrian sidewalk. Therefore, pedestrians are forced to move at main lane by sharing with vehicles. According to the information obtained from the response of questionnaire is 193(45.7%) illegal street vendors, 138(32.6%) construction materials, 72(17.1%) destructed roads and 20(4.7%) are utility poles.

How do you rate drivers give priorities to pedestrians as required by traffic law in Bahir Dar city?

Table 4. 14 Drivers give priority for pedestrian

Rating	frequency	Percentage (%)
Excellent	10	2.4

Good	20	4.7
Satisfactory	107	25.2
Poor	287	67.7
Total	424	100

Source; result of author's questionnaire survey

As we have seen from the above table problem of driver on pedestrian safety drivers are not giving priority for pedestrian is the main problem in the city of Bahir Dar. So, according to the respondents response rate driver giving priority for pedestrian is poor 287(67.7%), satisfactory 107(25.2%), good 20(4.7%), and excellent 6(2.4%). Therefore, drivers giving priority for a pedestrian is very weak or poor.

4.6 Open ended questions for pedestrians, cyclists, and other concerned bodies

Different open ended questions are asked to pedestrians, cyclists, traffic polices, traffic engineers etc. about the problems and recommended solutions of non-motorized (walking and cycling) transport in the city of Bahir Dar. Most respondents identify more problems concerned non-motorized transport in Bahir Dar city and propose solution to come up the problem. Depending on the type proposed solutions the researcher categorized in to different groups.

What are the solutions to solve the problem of pedestrians and cyclists in Bahir Dar city?

1. Change the behavior of drivers and pedestrians or society in general

Change the behavior or attitude of drivers and pedestrians about the concept of traffic rules and regulations and its effect on traffic accident is very important to solve different problems that occurred on pedestrians. Drivers should be informed or get continuous information about the rules and regulation of traffic like to drive within limited design speed, to give priority for pedestrians at necessary place and time and to drive on the right lane. And also pedestrians must have a knowledge about traffic rules and regulations like to move at the left side of the road, to cross the road use only pedestrian crossing place or Zebra and not to move on vehicles road. Then properly penalize those drivers and pedestrians who violate the traffic rule and regulations. Give driver license by properly evaluate his ability and attitude on rules and regulation traffic safety in general and pedestrians. Enough number of traffic police should be available at the place of congested road, Zebra crossing and presence of more pedestrians to control and manage

the traffic flow and penalize drivers and pedestrians who violates the traffic rule. And also encourage the society to participate in voluntary activities especially students to control, manage and guide and give direction for pedestrians and drivers.

2. Manage construction and waste materials found on the sidewalk

As it has been observed from the questionnaire most respondents agreed that presence of construction materials on the road or sidewalk are the main problems next to illegal street vendors. Contractors or those that construct a building are put their construction materials like aggregate, sand and reinforcement as well as their waste construction materials for long period of time are on the side of the road. These makes pedestrians forced to move in to the main lane by sharing of road with vehicles and exposes to congestion and traffic accident. There are also people who drop liquid and solid waste materials at the place of sidewalk or in general at the side the road. This creates bad smelling at those pedestrians and makes the place unattractive. Therefore, the concerned body should follow and control to put the construction material and different type of wastes at the right place within short period of time as soon as possible.

3. Construct over and under pass bridges on congested intersections

Construct over and under pass bridges on the area of intersection or the place where higher pedestrians are moved is very important to reduce conflicts to pedestrian with pedestrian and pedestrian with vehicle. This helps the pedestrian to cross the intersection safely without interaction of vehicles. Overpass and under pass bridges also made the road not congested. Because there is no much delay time in order to pass or give priority for pedestrians.

4. Construct wide and quality sidewalk and make safe and clean

Sidewalks are a pre-condition for those people who want to walk. Therefore, availability of wide and quality sidewalks is very important to increase the number passengers as a pedestrian. The Bahir Dar city municipality professionals should to plan and construct sufficient number of pedestrian walkways. In addition to these providing of enough number of pedestrian crossing or Zebra and make it well visible by marking with necessary color. Properly designed side ditches should be constructed in order to flow the drainage. Since, the terrain Bahir Dar city is more of flat side ditches should be provided. If there is no proper drainage facility, the water will lay on the road and destruct traffic flow as well as the structural strength of the road pavement. To

reduce the pedestrian congestion on the primary roads, construction of pedestrian walkways at local and collector roads and also control and those parked vehicles on the road especially at the market day. In addition of construct new roads and sidewalks, it is also necessary to quickly repair or maintain the destructed roads and sidewalks. Separate or fence pedestrian walkway from those vehicle roads to protect sudden entrance and exit of pedestrians and vehicles. Construct islands at the place of Zebra crossing for the purpose of pedestrians take rest and manage the traffic flow. When road sidewalks are constructed professionals properly plan and forecast the number of pedestrians, decide the capacity and construct by using quality materials and also create coordination with different stakeholders not to destruct the road after constructed, for example coordination of water works and electric corporation.

5. **Control illegal street vendors that work on the sidewalk**

Illegal street vendor means those people that sell their products and commodities on the street or sidewalk by moving here and there or sitting temporarily on the road where more pedestrians are present. Therefore, these street vendors occupy the sidewalk and pedestrians are forced to move on the main road. The concerned body should make legal and give proper market place. There are a number of shoe shine boys who occupies and works at the sidewalk area in the center of the city or center of CBD. These shoeshine boys should be shifted to another place in order to use the full capacity of the sidewalk. In addition to illegal street vendors, there are also traders who use the side of the road next to their house for the purpose of grocery, selling coffee, shopping, etc.

4.7 Potentials of Bahir Dar city for pedestrians and cyclist

What are the potential of non-motorized transport within Bahir Dar city?

1. **Flat topography**

The main opportunity of pedestrian transport in Bahir Dar city is it's important of topographic feather. The town stretches over a predominantly flat land with imperceptible slope changes, except for small rises in its eastern and western peripheries. The slope varies from apparently zero to slightly over 20 percent in few places. Most parts of the city, however, stretch on areas below 2 percent slope (BDIDP, 2006). This good topographic environment makes suitable for pedestrians, cyclists and in general for non-motorized transport systems.

2. Quality pedestrian walkways and other road side facilities

In the city relatively there is a good quality pedestrian walkway along the side of the road and some sidewalk roads are separated from main road to reduce conflict between vehicles. Presence of attractive plants (like Zembaba) at the side of the road makes pedestrians more comfortable and initiate to use the mode of walking. These plants also used for protecting the pedestrian from sun light. Even if not enough and equally distributed in the city there are public sitting chairs for tired people along the side of the road especially concentrated around Tana recreational area. There are also roads which are newly constructed and have wide and good quality pedestrian walkway facilities.

4.8 Questionnaires for the conditions of Bicycle transport infrastructural rating, and challenges

In most parts of the people Bicycle transport is highly motivated by exercise and enjoyment.

What is the reason for the reduction of Bicycle transport in Bahir Dar city?

Table 4. 15 Reasons to reduction of Bicycle transport

Reasons	Frequency	Percentage (%)
Absence of bike lanes/roads too narrow	100	24.2
No sidewalks or shoulder	63	15.2
Roads too busy/ too much traffic	178	43.0
Health issues	10	2.4
Absence of street lights	38	9.1
Destination distance is too far	25	6.1
Total	414	100

Source; result of author's questionnaire survey

In Bahir Dar city the preferred mode of transport were Bicycle. But now due to many reasons Bicycle transport usage is reduced. Among so many reasons identified by respondents were roads too busy/too much traffic 178(43.0%), absence of bike lanes/roads too narrow 100(24.2%), no sidewalks or shoulder 63(15.2%) and absence of street light 38(9.1%) are the major one.


Figure 4. 4 problem of cyclists due to congested traffic and lack parking

What facility changes do you recommend to increase Bicycle users in Bahir Dar city?

Table 4. 16 Recommended facility changes to increase bicycle users

Recommended changes to increase bicycle users	Frequency	Percentage (%)
Provide bicycle facilities (bike lanes, parking, racks, safe signals, and intersections)	190	45.9
Improve existing road facilities	73	17.6
Apply laws governing bicycles	48	11.6
Initiating bicycle safety education for drivers	103	24.9
Total	414	100

Source; result of author's questionnaire survey

To increase a number of bicycle users in the city the concerned body should plan some infrastructural facility changes and give awareness about advantage Bicycle transport to the society. Among the recommended changes provide Bicycle facilities (bike lanes, parking, racks, safe signals and intersections) 190(45.9%), initiating Bicycle safety education for drivers 103(24.9), improving existing road facilities 73(17.6), and apply laws governing Bicycles 48(11.6%).

Where you ride your bicycle in Bahir Dar city?

Table 4. 17 Bicycle riding place

Ride on	Number of respondent	Percentage (%)

On the carriageway	283	68.4
On the sidewalk/walkway	68	16.4
Whatever obstacles on their way	63	15.2
Total	414	100

Source; result of author's questionnaire survey

Absence of segregated bike lane is the main challenge to the reduction of Bicycle transport in Bahir Dar city. According to the respondent most Bicycle users drive on the carriageway 283(68.4%), on the sidewalk/walkway 68(16.4%), and whatever obstacles on their way 63(15.2%).

What problems or challenges in Bahir Dar city are more encountered while using a Bicycle?

Table 4. 18 Barriers or problems of bicycle transport

Barrier	Frequency	Percentage (%)
Bicycle theft	125	30.3
Parking problem	140	33.9
Traffic accident	33	7.9
Congested traffic	90	21.8
Quality of road	25	6.1
Total	413	100

Source; result of author's questionnaire survey

Figure 4. 5 problem of Bicycle transport in Bahir Dar city

Now, in Bahir Dar city a number of challenges or problems are occurred like parking problem 56(33.9), Bicycle theft 125(30.3), congested human and vehicle traffic 90(21.8%), traffic accident 33(7.9%) and quality of road 25(6.1%).

Do you get Bicycle parking facilities or places in Bahir Dar city (at bus stations, shopping centers, public offices)?

Rate of respondents that get enough parking place around Bus station, market centers, and institute of public service area or any other working places in the city of Bahir Dar identified. Most Bicycle users have not get enough parking place in the city. Therefore, most people are parked their Bicycle on the road, in front of shop or offices or in general unsafe places.

Table 4. 19 parking place

Get enough parking place	Number of respondent	Percentage (%)
Yes	73	17.7
No	340	82.3
Total	413	100

Source; result of author's questionnaire survey

How do you rate the condition of Bicycle infrastructure in Bahir Dar city?

In general the rate of Bicycle transport infrastructure is determined as in a poor 175(42.3%) due to lack of bike lane, satisfactory 173(41.8%), good 63(15.2%) and excellent 3(0.7%).

Table 4. 20 condition of Bicycle infrastructure

condition of infrastructure	Number of response	Percentage (%)
Excellent	3	0.7
Good	63	15.2
Satisfaction	173	41.8
Poor	175	42.3
Total	414	100

Source; result of author's questionnaire survey

Are there sufficient Bicycle spare part or maintenance places in Bahir Dar city?

Table 4. 21 Presence of Bicycle maintenance and spare parts

Rate of response	Number of response	Percentage (%)
Yes	172	53.1
No	152	46.9
Total	324	100

Source; result of author's questionnaire survey

4.9 What are the challenges or problems of Bicycle transport in Bahir Dar city? (Open ended questionnaire)

As it is cited in different documents, the most common and convenient way of traveling in Bahir Dar is cycling. As it is well known Bahir Dar city has a flat terrain topographical feather. So these makes safe and convenient for using Bicycles. But due to many challenges and problems people are forgotten and ignore the transport of Bicycles. According to the result of the questionnaire the problems and challenges Bicycle transport are summarized as follow.

a) **Absence of Bicycle lane:** The most frequently mentioned Bicycle transport problem in Bahir Dar city is the absence of Bicycle lane in all class of the road. This leads to decrease the number of Bicycle users because of traffic accident and congestion.

b) **Cost to a Bicycle:** The other problem is the increased cost of Bicycle. Buying a Bicycle is cost to most of the people and there is a scarce of availability of different Bicycle level types in the market.

c) **Parking problem:** In most of work areas, recreational areas, educational areas or universities, colleges, poly techniques, and primary and secondary schools, and shop and market areas have no parking facility or area. Due to these problems peoples are forced to use another transport type like Bajaj which is available in the nearby.

d) **Bicycle theft:** There are peoples which stole Bicycle in the city. When people use Bicycle they place their cycles at the side of the road, or a place of nearby destination point without Bicycle keeper or without control. When the Bicycle users do their needs or works or go another place for their work, the thief takes the Bicycle.

e) **Traffic accident:** Due to the absence of Bicycle lane, Bicycle users are using the main road by sharing with the vehicles. In the main road vehicle drivers are driving by over speeding. These leads to an accident crash of a Bicycle with a vehicle. The number of Bicycle traffic accident is small because of the number of Bicycle users are decreasing from year to year.

f) **Problem of training place:** In the city, there are no enough Bicycle training places for youths and peoples that want to drive a Bicycle.

g) **Traffic congestion:** It is the condition on the road networks that occurs as user increase, and characterized by slower speeds, longer trip time and increasing vehicular queues on the road. The city roads are occupied by different users like pedestrians, illegal street vendors, Bajaj and vehicles. These makes the road more crowded and congested. Since Bicycle users have no their own lane, and shared the road with these road users the road is very congested. So it is difficult to drive on this congested and crowded road condition.

h) **Increased alternative mode of transport:** an increased number of transportation modes decreases the usage of Bicycle and shifted to other mode of transport which is easily available and safe mode of transport.

i) **Problem of traffic safety awareness:** vehicle drivers should give respect for Bicycle users. Awareness of all drivers by the concerned body or by road and transport professionals, traffic polices, and a municipal professional about their right and obligation and traffic safety is important to reduce traffic accident.

j) **Lack of rent Bicycles:** To encourage the number of Bicycle users in the city there must be a Bicycle rental service. When Bicycle rental services exist in the city more people are interested to rent and drive with reasonable cost.

k) **Problem of driving skill:** because of lack of availability of Bicycle and training place, most cities people have not good driving skill. So when people are get the chance of driving on the road they make a fault and cause for the occurrence of an accident.

l) **Problem of quality road:** In the city especially on the major roads there are relatively good quality road facilities. But on some major roads and secondary and tertiary roads the quality of the road is not good.

m) **Lack of respect by vehicle drivers for Bicycle driver:** some vehicle drivers do not respect the right of Bicycle drivers. Since bicycle is one mode of transport every driver should respect the right of the bicycle.

n) **Over speed of vehicles:** There are drivers that drive by violating the limited speed of the road. These makes Bicycle riders fear of using the Bicycle. Over speed of the vehicle is the main cause of the traffic accident.

o) **Over load of Bicycle:** One Bicycle can carry only one person. But some people are driving a Bicycle more than one person. This makes the cause for an accident.

p) **Illegal street vendors:** In the city there are a number of illegal street merchants who have not their own market place. These illegal street vendors are sold their commodities at the side walk and on the asphalt especially at the time of peak hours i.e. at the morning and the evening.

q) **On road parking:** on road parking is common in the city Bahir Dar city. Especially, Bajaj and Taxis are load and unload on the major road. This makes the road very narrow and cause for an accident and congestion.

r) **Lack of smart Bicycles in the market:** In the city there is no smart and modernized Bicycles to attract and initiate to buy the Bicycle. When enough number and modern

Bicycles are available in the market peoples that have enough money are willing to buy the Bicycle to them and their children or family.

4.10 What are the potentials or opportunities of using Bicycle transport in Bahir Dar city?

According to the result of the questionnaire and open ended questions, in Bahir Dar city there are many opportunities to attract cyclists. Some of them are listed here.

a) **Safe topography:** The main opportunity of using Bicycle transport in Bahir Dar city is it's important of topographic feather. The town stretches over a predominantly flat land with imperceptible slope changes, except for small rises in its eastern and western peripheries. The slope varies from apparently zero to slightly over 20 percent in few places. Most parts of the city, however, stretch on areas below 2 percent slope (BDIDP, 2006). This good topographic environment makes suitable for pedestrians, cyclists and in general for non-motorized transport systems.

b) **Good environment:** The environmental condition includes mainly the weather condition or precipitation and temperature, soil type, location and area etc. Therefore, these conditions are good and safe to drive a Bicycle.

c) **Presence of street light:** Most primary and secondary roads have attractive road side facilities such as presence of trees or Zembaba and other beautiful plants and good Florescent light poles. Therefore, these road facilities initiate Bicyclers to use Bicycle and drive safely.

d) **More alternative roads:** The city has secondary, local and collector roads in addition to the primary roads. Therefore, these roads are comfortable to drive the Bicycle especially at the day when the primary road became congested. At night these class of road have not street light and it exposes to thief and robbery.

e) **Most trips in the city are not too far from the origin:** as it has been observed from the time taken from origin to destination 79.73% of the trip takes within the time range of [1 – 40] minute and 95.05% the trip takes less than one hour. This makes the city more comfortable to use the Bicycle.

4.11 Statistics result of pedestrian and cyclist

Table 4. 22 descriptive statistics

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
Age	425	2.12	.026	.531	.282
Sex	425	1.30	.024	.485	.235
Level of education	425	4.00	.053	1.101	1.212
Occupation	425	1.84	.049	1.011	1.023
Mostly available transport system in Bair Dar city	425	4.39	.092	1.895	3.592
Preferred mode of transport in Bahir Dar city	425	2.59	.091	1.870	3.497
Reason why you select the above preferred mode of transport	425	3.05	.055	1.144	1.309
Purpose of the journey	425	1.49	.043	.885	.783
Time to reach destination	425	1.68	.045	.918	.842
Satisfaction by the time taken	425	1.58	.024	.503	.253
Valid N (list wise)	425				

Generally, Standard error of mean of this distribution individual sample mean is in relation to the true mean with 95% confidence interval and that 5% maximum error of the estimate and standard error of mean is less than maximum error of the estimate. As a result, response of both cyclists and pedestrians are reliable and more accurate to support the required objective and conclude.

4.12 Traffic counts summary

Here the author tried to count traffics on three different parts of the road in Bahir Dar city. Traffics are categorized in to small car, Bajaj, mini bus, large bus, Bicycle, animal cart, hand cart, motor bike and pedestrians. Among these, when we see the level of non-motorized transport there were an average of 827 bicycles, 334 animal cart, 62 hand cart and 22079 pedestrians counted on the selected route section. In general totally 23302 peoples were considered as a pedestrian user. When we consider the average capacity of small car 2 passengers, Bajaj 3 passengers, mini bus 12 passengers, large bus 45 passengers and motor bike 1 passenger then the total number of passengers transported were 51717 according to the survey. Therefore, an average total number of 75019 passengers and pedestrians were used the road. When we see the ratio of pedestrians to total number of road user about 31.1% of road users were considered as pedestrians. Therefore, for these amount of pedestrians or non-motorized transport users'

sufficient non-motorized transport facilities or sidewalks, crossings, and other facilities should be full filed.

Table 4. 23 Summary of traffic tally

Mode	Debr Markos	Gondar	Motta	Average
Small car	1299	1464	1271	1345
Bajaj	10045	7968	5447	7820
Mini bus	1816	1680	1006	1500
Large bus	184	192	109	162
Bicycle	1120	912	448	827
Animal cart	271	168	562	334
Hand cart	56	24	106	62
Motor Bike	392	102	336	277
pedestrian	35068	17760	13408	22079

Source; authors traffic count result

4.13 Pedestrian and Bicycle level of service (LOS) at selected route of Bahir Dar city

Here the author tried to determine level of service of pedestrian and Bicycle on selected road segments of Bahir Dar city. The selected road sections are around st.Giorgis signal intersection to Bahir Dar police commission, around st.Giorgis signal to Azwa hotel intersection, and also the link part of st.Giorgis roundabout to Papyrus hotel roundabout. Here the author tried to show the steps how to calculate the level of service of pedestrians and Bicycles for road segment of around st.Giorgis signal intersection to Azwa hotel intersection. The other road segments and links are determined by the same procedure.

1. **Pedestrian and Bicycle level of service given data for around st.Giorgis signal intersection to police commission,**

Field measured parameters for pedestrian level of service (PLOS) and Bicycle level of service (BLOS) around st.Giorigis signal intersection to Amhara police commission

Parameter	Symbol	Unit	Value
Total walkway width	W_T	ft	10

Adjusted fixed object effective width on inside of sidewalk	$W_{o,i}$	ft	0.2
Adjusted fixed object effective width on outside of sidewalk	$W_{o,o}$	ft	0.6
Shy distance on inside (curb side) of sidewalk	$W_{s,i}$	ft	1.5
Shy distance on outside of sidewalk	$W_{s,o}$	ft	1.5
Buffer width between roadway and sidewalk	W_{buf}	ft	6.8
Proportion of sidewalk length adjacent to a window display	p_{window}	deci.	0
Proportion of sidewalk length adjacent to a building face	$p_{building}$	deci.	0
Proportion of sidewalk length adjacent to a fence or low wall	p_{fence}	deci.	0.5
Effective width of fixed objects on inside of sidewalk	$\boldsymbol{\omega}_{o,i}$	ft	0.2
Effective width of fixed objects on outside of sidewalk	$\boldsymbol{\omega}_{o,o}$	ft	0.6
Pedestrian flow rate in the subject sidewalk (walking in both directions)	V_{ped}	veh/ ln	1542
Effective walk time for the phase serving the minor street through movement	$g_{walk,\ mi}$	s	70
Cycle length	C	s	120
Segment length	L	ft	5010
Number of traffic lanes crossed when traversing crosswalk	N_d	No.	3
Number of right turn channelizing islands along crosswalk	$N_{rtci.d}$	No.	0
Count of vehicles travelling on the major street during a 15 min period	$n_{15,\ mj}$	veh/ ln	54
Count of vehicles travelling on the major street during a 15 min period	$S_{85,\ mj}$	mi/hr	23.6
Proportion of on-street parking occupied	P_{pk}	deci.	0.22
Mid segment demand flow rate (direction nearest to the subject sidewalk)	v_m	veh/h	500
Number of through lanes on the segment in the subject direction of travel	N_{th}	No.	2
Diversion distance	Dd	ft	748
Distance to nearest signal control crossing	Dc	ft	374

Right turn demand flow rate	V_{rtor}	Veh/h	11
Left turn demand flow rate	v_{lt}	Veh/h	5
Bicycle parameters			
Bicycle flow rate	v_{bic}	Bicycle/ h	145
Effective green time for Bicycle lane	g_b	s	30
Cycle length	C	s	120
Length of segment	L	ft	5010
Curb to curb width of the cross street	W_{cd}	ft	30
Total width of the outside through lane, Bicycle lane, and paved shoulder	W_t	ft	8
Left turn demand flow rate	v_{lt}	veh/h	160
Through demand flow rate	v_{th}	veh/h	654
Right turn demand flow rate	vrt	veh/h	186
Number of through lanes (shared or exclusive)	N_{th}	ln	2
Width of outside through lane	W_{ol}	ft	8
Width of the Bicycle lane	W_{bl}	ft	0
Proportion of on street parking occupied	P_{pk}	deci.	0.22
Width of paved outside shoulder	W_{os}	ft	8
Adjusted mid segment demand flow rate	v_{ma}	veh/h	720
Number of through lane on the segment in the subject direction of travel	N_{th}	ln	2
Adjusted percent heavy vehicles in mid segment demand flow rate	P_{Hva}	deci.	0.21
Number of access point approaches on the right side in the subject direction of travel	$N_{ap,\ s}$	No.	8

Calculated and given parameters to determine pedestrian level of service (PLOS) Around Giorigis signal intersection to Amhara police commission

Parameter	Source	Unit	Value
Average pedestrian free flow walking speed	HCM	Ft/s	4.4
Effective sidewalk width	Equation 3-2 to 3-6	ft	3.2
Pedestrian flow rate per unit width	Equation 3-7	p/ft/min	8.03
Average walking speed	Equation 3-8	Ft/s	4.18
Pedestrian space	Equation 3-9	Ft^2/p	31.23
Pedestrian delay at intersection	Equation 3-10	s/p	10.42
Pedestrian travel speed	Equation 3-11	Ft/s	4.144
Pedestrian LOS score for intersection	Equation 3-12 to 3-17	-	2.164
Pedestrian LOS score for link	Equation 3-18 to 3-21	-	2.105
Determine link LOS	From table		C
Roadway crossing difficulty factor	Equation 3-22 to 3-24	-	0.767
Pedestrian LOS score for segment	Equation 3-25	-	2.14
Determine segment LOS	From table	-	C
Bicycle parameters and level of service (BLOS)			
Parameter	Source	Unit	Value
Bicycle running speed	HCM 2010	mi/h	15
Bicycle delay at the intersection	Equation 3-26 and 3-27	s	36.4
Bicycle travel speed	Equation 3-28	mi/h	12.93
Bicycle LOS score for intersection	Equation 3-29 to 3-32	-	8.36
Bicycle LOS score for link	Equation 3-33 to 3-37	-	4.386
Determine Link LOS	From table	-	E
Bicycle LOS score for segment	Equation 3-38	-	3.86
Determine segment LOS	From table	-	C

PLOS around Giorigis signal intersection to police commission

2. **Pedestrian and Bicycle level of service given data for around st. Giorgis signal intersection to Aziwa hotel,**

Field measured parameters for pedestrian level of service (PLOS) and Bicycle level of service (BLOS) around st.Giorigis signal intersection to Aziwa hotel

Parameter	Symbol	Unit	Value
Total walkway width	W_T	ft	12.58
Adjusted fixed object effective width on inside of sidewalk	$W_{o,i}$	ft	0.68
Adjusted fixed object effective width on outside of sidewalk	$W_{o,o}$	ft	2.04
Shy distance on inside (curb side) of sidewalk	$W_{s,i}$	ft	1.5
Shy distance on outside of sidewalk	$W_{s,o}$	ft	1.5
Buffer width between roadway and sidewalk	W_{buf}	ft	7.48
Proportion of sidewalk length adjacent to a window display	p_{window}	deci.	0
Proportion of sidewalk length adjacent to a building face	$p_{building}$	deci.	0
Proportion of sidewalk length adjacent to a fence or low wall	p_{fence}	deci.	0
Effective width of fixed objects on inside of sidewalk	$\boldsymbol{\omega}_{o,i}$	ft	0.68
Effective width of fixed objects on outside of sidewalk	$\boldsymbol{\omega}_{o,o}$	ft	2.04
Pedestrian flow rate in the subject sidewalk (walking in both directions)	V_{ped}	Ped/h	1840
Effective walk time for the phase serving the minor street through movement	$g_{walk,\ mi}$	s	70
Cycle length	C	s	120
Segment length	L	ft	3400
Number of traffic lanes crossed when traversing crosswalk	N_d	No.	3
Number of right turn channelizing islands along crosswalk	$N_{rtci.d}$	No.	0
Count of vehicles travelling on the major street during a 15 min period	$n_{15,\ mj}$	veh/ ln	54
Count of vehicles travelling on the major street during a 15 min period	$S_{85,\ mj}$	mi/hr	48
Proportion of on-street parking occupied	P_{pk}	deci.	0.175
Mid segment demand flow rate (direction nearest to the subject sidewalk)	v_m	veh/h	482
Number of through lanes on the segment in the subject	N_{th}	No.	2

direction of travel			
Diversion distance	Dd	ft	680
Distance to nearest signal control crossing	Dc	ft	340
Right turn demand flow rate	V_{rtor}	Veh/h	11
Left turn demand flow rate	v_{lt}	Veh/h	5
Bicycle field measured parameters			
Bicycle flow rate	v_{bic}	Bic/ h	194
Effective green time for Bicycle lane	g_b	s	30
Cycle length	C	s	120
Length of segment	L	ft	3400
Curb to curb width of the cross street	W_{cd}	ft	30.6
Total width of the outside through lane, Bicycle lane, and paved shoulder	W_t	ft	8.16
Left turn demand flow rate	v_{lt}	veh/h	160
Through demand flow rate	v_{th}	veh/h	645
Right turn demand flow rate	vrt	veh/h	0
Number of through lanes (shared or exclusive)	N_{th}	ln	2
Width of outside through lane	W_{ol}	ft	8.16
Width of the Bicycle lane	W_{bl}	ft	0
Proportion of on street parking occupied	P_{pk}	deci.	0.175
Width of paved outside shoulder	W_{os}	ft	8.16
Adjusted mid segment demand flow rate	v_{ma}	veh/h	720
Number of through lane on the segment in the subject direction of travel	N_{th}	ln	2
Adjusted percent heavy vehicles in mid segment demand flow rate	P_{Hva}	deci.	0.21
Number of access point approaches on the right side in the subject direction of travel	$N_{ap,\ s}$	No.	

Calculated and given parameters to determine pedestrian level of service (PLOS) and Bicycle level of service (BLOS) around Giorigis signal intersection to Aziwa hotel

Parameter	Source	Unit	Value
Average pedestrian free flow walking speed	HCM	Ft/s	4.4
Effective sidewalk width	Equation 3-2 to 3-6	ft	5.1
Pedestrian flow rate per unit width	Equation 3-7	p/ft/min	7
Average walking speed	Equation 3-8	Ft/s	4.232
Pedestrian space	Equation 3-9	Ft^2/p	36.273
Pedestrian delay at intersection	Equation 3-10	s/p	10.42
Pedestrian travel speed	Equation 3-11	Ft/s	2.185
Pedestrian LOS score for intersection	Equation 3-12 to 3-17	-	2.34
Pedestrian LOS score for link	Equation 3-18 to 3-21	-	1.93
Determine link LOS	From table		**C**
Roadway crossing difficulty factor	Equation 3-22 to 3-24	-	0.769
Pedestrian LOS score for segment	Equation 3-25	-	2.1
Determine segment LOS	From table	-	**C**
Bicycle parameters and level of service (BLOS)			
Parameter	Source	Unit	Value
Bicycle running speed	HCM 2010	mi/h	15
Bicycle delay at the intersection	Equation 3-26 and 3-27	s	37.36
Bicycle travel speed	Equation 3-28	mi/h	12.08
Bicycle LOS score for intersection	Equation 3-29 to 3-32	-	7.02
Bicycle LOS score for link	Equation 3-33 to 3-37	-	3.15
Determine Link LOS	From table	-	**E**
Bicycle LOS score for segment	Equation 3-38	-	3.9
Determine segment LOS	From table	-	

PLOS and BLOS around Giorigis signal intersection to Aziwa hotel

3. Pedestrian and Bicycle level of service given data for around roundabout st. Giorgis to Papyrus hotel,

Field measured parameters for pedestrian level of service (PLOS) and Bicycle level of service (BLOS) around st.Giorigis signal intersection to Aziwa hotel

Parameter	Symbol	Unit	Value
Total walkway width	W_T	ft	12.24
Adjusted fixed object effective width on inside of sidewalk	$W_{o,i}$	ft	0.68
Adjusted fixed object effective width on outside of sidewalk	$W_{o,o}$	ft	2.04
Shy distance on inside (curb side) of sidewalk	$W_{s,i}$	ft	1.5
Shy distance on outside of sidewalk	$W_{s,o}$	ft	1.5
Buffer width between roadway and sidewalk	W_{buf}	ft	6.8
Proportion of sidewalk length adjacent to a window display	p_{window}	deci.	0.2
Proportion of sidewalk length adjacent to a building face	$p_{building}$	deci.	0.4
Proportion of sidewalk length adjacent to a fence or low wall	p_{fence}	deci.	0.25
Effective width of fixed objects on inside of sidewalk	$\boldsymbol{\omega}_{o,i}$	ft	0.68
Effective width of fixed objects on outside of sidewalk	$\boldsymbol{\omega}_{o,o}$	ft	2.04
Pedestrian flow rate in the subject sidewalk (walking in both directions)	V_{ped}	Ped/h	2118
Effective walk time for the phase serving the minor street through movement	$g_{walk,\ mi}$	s	
Cycle length	C	s	
Segment length	L	ft	2720
Number of traffic lanes crossed when traversing crosswalk	N_d	No.	3
Number of right turn channelizing islands along crosswalk	$N_{rtci.d}$	No.	0
Count of vehicles travelling on the major street during a 15 min period	$n_{15,\ mj}$	veh/ ln	
Count of vehicles travelling on the major street during a 15 min period	$S_{85,\ mj}$	mi/hr	
Proportion of on-street parking occupied	P_{pk}	deci.	
Mid segment demand flow rate (direction nearest to the	v_m	veh/h	

subject sidewalk)			
Number of through lanes on the segment in the subject direction of travel	N_{th}	No.	
Diversion distance	Dd	ft	
Distance to nearest signal control crossing	Dc	ft	
Right turn demand flow rate	V_{rtor}	Veh/h	
Left turn demand flow rate	v_{lt}	Veh/h	
Bicycle parameters			
Bicycle flow rate	v_{bic}	Bic/ h	
Effective green time for Bicycle lane	g_b	s	
Cycle length	C	s	
Length of segment	L	ft	
Curb to curb width of the cross street	W_{cd}	ft	
Total width of the outside through lane, Bicycle lane, and paved shoulder	W_t	ft	
Left turn demand flow rate	v_{lt}	veh/h	
Through demand flow rate	v_{th}	veh/h	
Right turn demand flow rate	vrt	veh/h	
Number of through lanes (shared or exclusive)	N_{th}	ln	
Width of outside through lane	W_{ol}	ft	
Width of the Bicycle lane	W_{bl}	ft	
Proportion of on street parking occupied	P_{pk}	deci.	
Width of paved outside shoulder	W_{os}	ft	
Adjusted mid segment demand flow rate	v_{ma}	veh/h	783
Number of through lane on the segment in the subject direction of travel	N_{th}	ln	2
Adjusted percent heavy vehicles in mid segment demand flow rate	P_{Hva}	deci.	
Number of access point approaches on the right side in the subject direction of travel	$N_{ap,\ s}$	No.	

Calculated and given parameters to determine pedestrian level of service (PLOS) and Bicycle level of service (BLOS) at roundabout of st.Giorgis to Papyrus hotel

Parameter	Source	Unit	Value
Average pedestrian free flow walking speed	HCM	Ft/s	4.4
Effective sidewalk width	Equation 3-2 to 3-6	ft	3.12
Pedestrian flow rate per unit width	Equation 3-7	p/ft/min	12
Average walking speed	Equation 3-8	Ft/s	3.96
Pedestrian space	Equation 3-9	Ft^2/p	20.97
Pedestrian delay at intersection	Equation 3-10	s/p	
Pedestrian travel speed	Equation 3-11	Ft/s	
Pedestrian LOS score for intersection	Equation 3-12 to 3-17	-	
Pedestrian LOS score for link	Equation 3-18 to 3-21	-	1.46
Determine link LOS	From table		**D**
Roadway crossing difficulty factor	Equation 3-22 to 3-24	-	
Pedestrian LOS score for segment	Equation 3-25	-	
Determine segment LOS	From table	-	
Bicycle parameters and level of service (BLOS)			
Parameter	Source	Unit	Value
Bicycle running speed	HCM 2010	mi/h	4.4
Bicycle delay at the intersection	Equation 3-26 and 3-27	s	
Bicycle travel speed	Equation 3-28	mi/h	
Bicycle LOS score for intersection	Equation 3-29 to 3-32	-	
Bicycle LOS score for link	Equation 3-33 to 3-37	-	3.75
Determine Link LOS	From table	-	**D**
Bicycle LOS score for segment	Equation 3-38	-	
Determine segment LOS	From table	-	

PLOS around Giorigis signal intersection to police commission

4.14 Discussion of pedestrian and Bicycle level of service on selected route segment

Pedestrian and Bicycle level of service is discussed in this section. Pedestrian and Bicycle level of service around st.Giorgis signal intersection to police commission, around st.Giorgis signal intersection to Azwa hotel and the link from st.Giorgis roundabout to Papyrus hotel is determined by considering speed of pedestrian and Bicycles, sidewalk and outside through lane width, obstacles on the sidewalk or presence of fixed objects, number of pedestrians and Bicycles or pedestrian space, presence of buffer area, number of vehicles using the segment etc. The pedestrian and Bicycle level of service for the link or length the road is determined by considering cross section adjustment factor, motorized volume and speed adjustment factor, pavement condition adjustment factor and average pedestrian space. By considering the above parameter's and using the methodology of highway capacity manual (HCM) the level of service of each link and segment is determined and summarized on the table below.

Table 4. 24 Link LOS of pedestrian (source; HCM exhibit 17-3)

Pedestrian LOS score	LOS by average pedestrian space (ft^2/p)					
	>60	>40-60	>24-60	>15-24	>8.0-15[a]	≤8.0[a]
≤2.00	A	B	C	D	E	F
>2.00-2.75	B	B	C	D	E	F
>2.75-3.50	C	C	C	D	E	F
>3.50-4.25	D	D	D	D	E	F
>4.25-5.00	E	E	E	E	E	F
>5.00	F	F	F	F	F	F

Note [a]In cross flow situations, the LOS E/F threshold is 13ft^2/p

Table 4. 25 Pedestrian LOS for selected road sections of Bahir Dar city

Road segment	Pedestrian space (ft^2/p)	Link LOS score	Link LOS	Segment LOS score	Segment LOS
Around st.Giorgis intersection to police commission commissioner	31.23	2.105	C	2.13923	C
Around st.Giorgis signal intersection to Azwa hotel	36.2728	1.9249	C	2.100	C
Link from st.Giorgis to Papyrus hotel	20.97	1.459	D	-	-

Table 4. 26 Bicycle LOS criteria

Level Of Service (LOS)	LOS score
A	≤2.00
B	>2.00-2.75
C	>2.75-3.50
D	>3.50-4.25
E	>4.25-5.00
F	>5.00

Source; HCM exhibit 17-4

Table 4. 27 Bicycle LOS for selected road sections of Bahir Dar city.

Road segment	Intersection LOS score	Link LOS score	Link LOS	Segment LOS score	Segment LOS
Around st.Giorgis intersection to police commission commissioner	8.364325	4.386	E	3.8586	D
Around st.Giorgis signal intersection to Azwa hotel	7.014225	3.1465561	C	3.88424	D
Link from st.Giorgis to Papyrus hotel	20.97	3.745	D	-	-

4.15 Pedestrian vehicle conflict analysis on selected crosswalk routes of Bahir Dar city

Table 4. 28 Most frequently Observed traffic conflicts in Bahir Dar city

Type of traffic accident	Frequency	Percentage (%)
Motor vehicle with motor vehicle	52	14.77
Motor vehicle with Bicycle	22	6.25
Motor vehicle with Bajaj	82	23.30
Motor vehicle with Pedestrians	57	16.19
Motor vehicle with static object	27	7.67
Motor vehicle with horse drawn cart	12	3.41
Horse drawn cart with pedestrians	4	1.14
Bajaj with horse drawn carts	10	2.84
Bajaj with Bajaj	40	11.36
Bicycle with Pedestrians	40	11.36

Bicycle with Bicycle	6	1.71
Total	352	100

Source; result of author's questionnaire survey

In the city of Bahir Dar most accidents that frequently occurred are the collision between motor vehicle with Bajaj (23.3%), motor vehicle with pedestrians (16.19%), motor vehicle with motor vehicle (14.77%), Bajaj with Bajaj (11.36%) and Bicycle with Bicycle with the respondents' response rate. These is due to an increasing number of motorized transport i.e. Bajaj, Taxi and other private and governmental vehicles.

To study the feasibility, applicability and effectiveness of pedestrian vehicle conflict study were conducted at four selected pedestrian crossing locations. Two of the crosswalk locations were found at mid segment of the route and two were found at the place of intersection. These locations are critical to determine the pedestrian vehicle conflict severity. The type of roadway that all conflict study locations were two way separated by median and have two lanes in each direction. The intersection crosswalk locations are found at North West direction around Noc signal intersection and the other is found around Papyrus hotel of roundabout.

At papyrus hotel roundabout intersection 2531 average pedestrians per hour were crossing the road. At this intersection more pedestrian vehicle conflicts were takes place. At this intersection crossing 619 total pedestrian vehicle conflicts were investigated at the time of survey. Among these conflicts 430(69%) were minor, 149(24%) were moderate and 65(13%) were severe conflicts.

The other intersection selected was around Noc signalizing intersection which is found at the entrance of Bahir Dar city in the west direction. This intersection is very crowded at the time of morning and evening. The counted average pedestrians were 1853 pedestrians per hour. 256 total average conflicts were observed. Among these conflicts 207(81%) were minor, 38(17%) were moderate and 11(4%) were severe conflicts as observed by the author.

The mid segment conflict study were conducted at the place from roundabout of papyrus hotel roundabout to st.Giorgis roundabout. This road segment has a very congested pedestrian and more business activities were takes place or central business district (CBD). Therefore, more pedestrian vehicle conflicts were occurred at this road segment crossing area. At this road segment about 3102 average pedestrians per hour were crossed the road. At the selected mid

segment 392 conflicts per hour were observed according to the authors survey. Out of these conflicts are 188(48%) were minor, 141(36%) were moderate and 63(16%) conflicts were severe.

The other mid segment crossing study area was conducted at the place of around st.Giorgis from signalized intersection to Azwa hotel called Mulualem road section. At this road segment about 1542 average pedestrians per hour were counted crossing the road. At the selected mid segment crossing area about 274 total conflicts per hour were observed. Out of this conflicts 173(63%) were minor, 63(23%) were moderate and 36(13%) were sever.

Table 4. 29 Conflict result summery

No	Selected site	pedestrians per hour	Total conflict	Average Conflict severity		
				minor	moderate	sever
1	Papyrus hotel roundabout	2531	619	430(69%)	149(24%)	65(11%)
2	Noc signalized intersection	1853	356	288(81%)	54(17%)	15(4%)
3	St.Giorgis roundabout to Papyrus	3102	392	188(48%)	141(36%)	63(16%)
4	St.Giorgis signalized intersection to Azwa hotel	1542	274	173(63%)	63(23%)	36(13%)

Source; authors survey result

As observed from the result above, more pedestrian vehicle conflicts were observed at the place of intersection pedestrian crossing due to drivers not give priority for pedestrians, but more sever conflicts were observed at the mid segment due to over speeding.

4.16 Causes of traffic accident on pedestrians, passengers and property damage reported by Bahir Dar traffic police commission

There are a number pedestrian traffic accident causes in the city of Bahir Dar that are listed at the time of occurrence of accident by the Bahir Dar city police commission commissioner. Bahir Dar city traffic police commission is responsible for completing, identifying or investigating the traffic accident causes and are expected to prepare different types of forms based on accident types. An accident code contains different selected causes for accident categorization. Categorization code can be putted as follows.

Table 4. 30 Causes of traffic accident by drivers 2007

No.	Causes of traffic accident	Type of Accident					%
		Death	Heavy injury	Slight injury	Property damage	Total	

1	Drink and Drive				1	1	0.32
2	Driving leaving the right lane	2			1	3	0.95
3	Not giving priority for other vehicle		2	6	34	42	13.33
4	Not giving priority for pedestrian	12	8	20	19	59	18.7
5	Not drive by giving enough headway			4	44	48	15.24
6	Pass the vehicle at steep grade			1		1	0.32
7	Passing at the curve			1		1	0.32
8	After passed suddenly change the lane				1	1	0.32
9	Over speeding	9	18	19	44	90	28.57
10	Not drive properly	3	4	5	12	24	7.62
11	Not turn properly		1	3	8	12	3.81
12	Violate the sign of give priority		1		5	6	1.9
13	improperly move at stop station				2	2	0.64
14	Stop improperly				2	2	0.64
15	Drivers felt tired and sleeping				1	1	0.32
16	Not give attention				1	1	0.32
17	Overloading				4	4	1.27
18	Dropping of wheel				1	1	0.32
19	Wheel burst	4			2	6	1.9
20	Problem of pedestrian			2		2	0.64
21	Other	2			1	3	0.95
22	Unknown	4		1		5	1.59
Total		36	34	62	183	315	100

Source; Bahir Dar city traffic police, 2007

The traffic police figure shows that the major causes of traffic accident are resulted from over speeding 90(28.57%), not giving priority for pedestrians 59(18.7%), not drive by giving enough headway 48(15.2%) and not giving priorities for other vehicles 42(13.3%).

Table 4. 31 Causes of traffic accident by drivers 2008

No.	Causes of traffic accident	Type of Accident					%
		Death	Heavy injury	slight injury	Property damage	Total	
1	Driving leaving the right lane		4	1	8	13	4.6
2	Not giving priority for other vehicle	3	2	10	49	64	22.6
3	Not giving priority for pedestrian	22	14	31		67	23.7
4	Not drive by giving enough headway	1	3	1	51	56	19.8
5	Passing at the curve	5			5	10	3.5
6	After passed suddenly change the lane			1	2	3	1.1

7	Over speeding	6	3	14	4	27	9.5
8	Not drive properly	1	2		6	9	3.2
9	Not turn properly	3	2	1	3	9	3.2
10	Violate the sign of give priority				5	5	1.8
11	improperly move at stop station				1	1	0.3
12	Dropping of wheel				6	6	2.1
13	problem of pedestrian	3				3	1.1
14	other			6	3	9	3.2
15	unknown	1				1	0.3
Total		45	30	65	143	283	100

Source; Bahir Dar city traffic police, 2008

The 2008 police report shows that the causes of all traffic accidents are not giving priority for pedestrian 67(23.7%), not giving priority for other vehicles 64(22.6%), not drive by giving enough headway 56(19.8%) and over speeding 27(9.5%).

Table 4. 32 Causes of traffic accident by drivers 2009

No.	Causes of traffic accident	Type of Accident					%
		Death	Heavy injury	slight injury	Property damage	Total	
1	Driving by taking Hashish		1	2		3	0.9
2	Driving leaving the right lane		2	4	1	7	2.2
3	Not giving priority for other vehicle	2	10	11	53	76	23.3
4	Not giving priority for pedestrian	26	5	6	14	51	15.6
5	Not drive by giving enough headway	2	3	1	59	65	19.9
6	Pass the vehicle at steep grade				1	1	0.3
7	Over speeding	16	5	20	31	72	22.1
8	Not drive properly	2	1	1	16	20	6.2
9	Not turn properly				3	3	0.9
10	Violate the sign of give priority				3	3	0.9
11	Improperly move at stop station				1	1	0.3
12	Stop improperly				1	1	0.3
13	Not give attention	1				1	0.3
14	Dropping of wheel		1			1	0.3
15	problem of pedestrians	1	1			2	0.6
16	Other	2		2	3	7	2.2
17	Unknown	4		3	5	12	3.7
Total		56	29	50	191	326	100

Source; Bahir Dar city traffic police, 2009

The above table shows various causes of traffic accident in the year 2009 reported by Bahir Dar city traffic police commission bureau. The major causes are not giving priority for other vehicles 76(23.3%), over speeding 72(22.1%), not drive by giving enough headway 65(19.9%) and not giving priority for pedestrians 61(18.7%). In addition to the above causes environmental conditions such as whether have important attributable causes for the occurrence of accident. According to the data obtained from Bahir Dar city commission commissioner, four most traffic accident causes are identified. These are serious and most frequently occurred of traffic accident and the concerned body should take proper countermeasures to these traffic accident problems.

Table 4. 33 Frequent causes of driver on pedestrian accident

No.	Causes	2007	2008	2009	Average	%
1	Over speeding	90	27	72	66	21.4
2	Not giving priority for pedestrians	59	67	61	63	20.5
3	Not giving priority for other vehicles	42	64	76	61	19.8
4	Not drive by giving enough headway	48	56	65	57	18.5
Total accident		315	283	326	308	80.2

Source: Bahir Dar city traffic police commission report 2007, 2008 and 2009.

Accident severity

As it has been seen at the table below from the total accidents that are occurred in Bahir Dar city 14.9% were death, 10% heavily injured, 19.1% light injury and 56% were property damage. The main causes of these accidents are over speeding, not giving priority for pedestrians, not giving priority for other vehicles, not drive by giving enough headway. Most traffic accidents causes were due to error of driver. Therefore, enough education should be given for the driver to respect and drive the traffic rule.

Accident severity	No. of accident				
	2007	2008	2009	Average	Accident severity (%)
Death	36	45	56	46	14.9
Heavy injury	34	30	29	31	10.0
Light injury	62	65	50	59	19.1
Property damage	183	143	191	173	56.0
Total	315	283	326	309	100

4.17 Movement of pedestrian and amount of Accident occurrence

It has been considered that almost self-evident to most people is safer to cross the road at Zebra crossing. The well-known fact is that most of the accidents where pedestrians have been hit by a car in urban areas occur either at Zebra crossing or at signalized intersection. It was considered obvious that this was caused by the high exposure at Zebra crossings and signalized intersections respectively. (Dr. Lars Ekman & Dr. Christer Hyden, 1999).

Table 4. 34 Movement of pedestrian accident severity 2007

No.	Movement of pedestrian	Type of accident				
		Death	Heavy injury	Slight injury	Total	%
1	crossing around un signalized intersection			1	1	1.1
2	crossing at signalized intersection diagonally			1	1	1.1
3	crossing at zebra	6	5	12	23	24.5
4	crossing without zebra	8	4	14	26	27.6
5	crossing the road following the vehicle	1	6	3	10	10.6
6	moving at pedestrians lane		2	1	3	3.2
7	without sidewalk move at left side	1	1	3	5	5.3
8	without sidewalk move at the right side		4	4	8	8.5
9	playing at the vehicles road			1	1	1.1
10	standing at the vehicles road			1	1	1.1
11	sleeping or sitting at the vehicles road	1			1	1.1
12	getting in and out of at the vehicle	1		1	2	2.1
13	out of vehicle and pedestrian lane	2			2	2.1
14	other	2	1	2	5	5.3
15	unknown	5			5	5.3
Total		27	23	44	94	100

Source: Bahir Dar city traffic police commission commissioner report 2007

From the table above movement of pedestrian that cause accident are crossing the road without zebra 26(27.7%), crossing the road at zebra 23(24.5%), crossing the road following the vehicle 10(10.6%) and move without sidewalk at the right lane 8(8.5%) among the major one.

Table 4. 35 Movement of pedestrians and accident severity 2008

No.	Movement of pedestrian	Type of accident				
		Death	Heavy injury	Slight injury	Total	%

1	Crossing at signalized intersection diagonally			2	2	1.9
2	Crossing at zebra	1	3	7	11	10.7
3	Crossing without zebra	8	5	12	25	24.3
4	Crossing the road following the vehicle	1		4	5	4.9
5	Moving at the vehicles lane	7		4	11	10.7
6	Without sidewalk move at left side	3	2	2	7	6.8
7	Without sidewalk move at the right side		4	2	6	5.8
8	Move at the center of vehicles lane	3	1	9	13	12.6
9	Playing at the vehicles road			1	1	1.0
10	Standing at the vehicles road	1		2	3	2.9
11	Sleeping or sitting at the vehicles road	2			2	1.9
12	Out of vehicle and pedestrian lane			1	1	1.0
13	Other	4		5	9	8.7
14	Unknown	3	2		5	4.9
15	Out of the road		1	1	2	1.9
Total		33	18	52	103	100

Source: Bahir Dar city traffic police commission commissioner report 2008

From the table above movement of pedestrian that cause accident are crossing the road without zebra 25(24.3%), move at the center of vehicles lane 13(12.6%), crossing the road at zebra crossing 11(10.7%), movement of pedestrian at vehicles lane, 11(10.7%) and move without sidewalk at the left side 7(6.8%) among the major one.

Table 4. 36 Movement of pedestrians and accident severity 2009

No.	Movement of pedestrian	Type of accident				
		Death	Heavy injury	Slight injury	Total	%
1	Crossing at signalized intersection diagonally	1	1	1	3	3.8
2	Crossing at zebra	9	3	4	16	20.3
3	Crossing without zebra	18	5	4	27	34.2
4	Crossing the road following the vehicle			1	1	1.3
5	Moving at the vehicles lane	1	1		2	2.5
6	Moving at pedestrians lane		2	4	6	7.6
7	Without sidewalk move at left side		2	3	5	6.3
8	Without sidewalk move at the right side	3		5	8	10.1
9	Getting in and out at the vehicle	1			1	1.3
10	Out of vehicle and pedestrian lane	2			2	2.5
11	Other	1		2	3	3.8
12	Unknown	1		3	4	5.1
13	Out of the road	1			1	1.3

Total	38	14	27	79	100

Source: Bahir Dar city traffic police commission commissioner report, 2009

According to the data obtained from 2009 Bahir Dar city traffic police commission commissioner most pedestrian traffic accidents are occurred at the place of crossing the road without Zebra 27(34.6%), cross the road at the place of Zebra crossing 16(20.5%) and without presence of sidewalk pedestrians move at the right side the road.

In general, according to the three year average traffic police accident data most or 46.8% of total pedestrian traffic accidents are occurred at the place of road crossing. Therefore, providing the required Zebra crossing at the right place of the road reduces pedestrian traffic conflicts or accident. The other accidents are occurred where pedestrians are move without sidewalk at the right side of the road, move without sidewalk at the left side, moving at the traffic lane with sharing of vehicles, moving at the center of the traffic lane, and moving at the pedestrian lane.

Table 4. 37 Frequent pedestrian movements that cause accident and number of accidents.

No.	Movement of pedestrians	2007	2008	2009	Average	%
1	Crossing without zebra	26	25	27	26	28.3
2	Crossing at zebra	23	11	16	17	18.5
3	Without sidewalk move at right side	8	6	8	8	8.7
4	Without sidewalk move at the left side	5	7	5	6	6.5
5	Crossing the road following the vehicle	10	5	1	6	6.5
6	Moving at the vehicles lane	0	11	2	5	5.4
7	Moving at the center of vehicles lane	0	13	0	5	5.4
Total accident		94	103	79	92	79.3

Source: Bahir Dar city police commission commissioner report, 2007, 2008 and 2009

Pedestrian accident severity

Among the three year pedestrian traffic accident about 35.5% were death and 20.4% were heavy injury which accounts more than 65% of total average pedestrian accident.

Accident severity	No. of accident				
	2007	2008	2009	Average	%
Death	27	33	38	33	35.5
Heavy injury	23	18	14	19	20.4
Light injury	44	52	27	41	44.1
Total	94	103	79	93	100

4.18 Injured peoples in Bahir Dar city by age group

The table below shows the three year (2007, 2008, and 2009) traffic accident of Bahir Dar city. The accidents are categorized in to death, heavy injury and light injury according to the Bahir Dar city traffic police commission. The data shows the accident of drivers, pedestrians and passenger based on age.

Table 4. 38 Injured peoples based on their age

Victims	Age group	Death			Heavy injury			Light injury			total
		2007	2008	2009	2007	2008	2009	2007	2008	2009	
Drivers	<18 years									1	1
	18-30 years	5	2	8	5		3	7		2	32
	31-50 years	2	1	1	2		1			1	8
	>51 years		1		2			2			5
	Total	**7**	**4**	**9**	**9**		**4**	**9**		**4**	**46**
Pedestrians	<7 years									1	1
	7-13 years	2	2		1	1	1		5		12
	14-17 years		9	10	1	5	2	1	19	1	48
	18-30 years	14	14	17	17	5	7	26	25	13	138
	31-50 years	8	6	7	2	5	3	14	2	4	51
	>51 years	4	2	3	1	2	1	4	1	1	19
	Total	**28**	**33**	**37**	**22**	**18**	**14**	**45**	**52**	**20**	**269**
Passengers	<7 years						1				1
	7-13 years			2			1				3
	14-17 years	2	1	8	7	1	14	14	1	2	50
	18-30 years	9	5	3	11	4	15	16	5	8	76
	31-50 years	2	12	1	1	1	6	1	1	3	28
	>51 years		3	1			1			1	6
	Total	**13**	**21**	**15**	**19**	**6**	**38**	**31**	**7**	**14**	**164**

Source; 2007, 2008, 2009 Bahir Dar city traffic police commission.

As it has been seen from the table most injured drivers, pedestrians and passengers are fall under the age of 18-30 years old. Based on the three year traffic accident data 51.3% of pedestrian accidents are under the productive age of 18-30 years.

4.19 Occupation of injured pedestrians

The table below shows the three year (2007, 2008, and 2009) traffic accident of Bahir Dar city based on occupation of injured pedestrians. The accidents are categorized in to death, heavy injury and light injury according to the Bahir Dar city traffic police commission.

Table 4. 39 Injured pedestrians based on occupation.

Occupation	Death			Heavy injury			Light injury				
	2007	2008	2009	2007	2008	2009	2007	2008	2009	Total	%
Students	8	6	1	3	3	3	11	11	15	61	21.7
Workers	12	15	14	10	6	8	27	15	13	120	**42.7**
Farmers	5	10	11	9	2	5	6	3	14	65	23.1
Job seekers		2	5	1	3	1		3	8	23	8.2
Unknown	2	4	2			1		1	2	12	4.3
Total	27	37	33	23	14	18	44	33	52	281	100

Source; 2007, 2008, 2009 Bahir Dar city traffic police commission.

From the year traffic police traffic police accident data most injured pedestrians are workers which may be governmental employers or private workers 120(42.7%), farmers 65(23.1%) and students 61(21.7%).

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

- In this study main Challenges of non-motorized transport (pedestrian) in Bahir Dar city were identified as walkways are occupied by illegal street vendors, construction materials, presence of utility poles and destructed roads (holes) on the walkway, congestion, and conflict with vehicles due to absence of segregated walkway, lack of street light at the time of night, lack of adequate sidewalk width, too few and invisible crosswalks/crossing facilities, illegal behavior of driver like: over speeding and not giving priority for pedestrian.
- In general Bicycle is the forgotten transport in Bahir Dar city as respondents' response rate due to poor infrastructural facilities. The main challenges on Bicycle transport were identified as absence of segregated Bicycle lanes, parking problem at different working places and offices, Bicycle theft, Lack of follow up by the concerned body or municipality of Bahir Dar to give Bicycle plate numbers and other necessary Bicycle facilities, lack of street light at the time of night, Congestion of the road due to the presence of three wheel vehicle or Bajaj and traffic accident, lack of Bicycle maintenance and Failure to incorporate NMT infrastructures in planning and development of transport infrastructure by Bahir Dar municipality or other concerned body.
- When we see the accident rate most injured pedestrians are fall under the age group of 18-30 years (51.3%) and workers (42.7%) which are employers and private and most productive part of the population.
- The level of service of pedestrian and bicycle is determined on selected links and segments of the road section. The level of service of pedestrian for road segments of around st.Giorgis signal intersection to police commission and around st.Giorgis signal intersection to Azwa hotel were determined as both LOS of C for link and segment section which means that frequent need to adjust the path to avoid conflicts with pedestrians each other. The other road section were from st.Giorgis roundabout to Papyrus hotel which the link level of service were determined as LOS D which means that speed and ability to pass pedestrians is restricted due to congested pedestrians.

- The pedestrian vehicle conflict study result shows that more conflicts were found at intersection crossing due to mainly drivers not give priority for pedestrians, more number of pedestrian cross at the same time and sever conflicts were found at mid segment due to over speeding and more parked vehicles on the road.

5.2 RECOMMENDATIONS

- The Bahir Dar city Administration municipality should provide Bicycle infrastructures (bike lanes, bike routes) that provides cycling access to major destinations (schools, commercial centers, intermodal terminals, and recreational areas), and connections to regional and provincial bicycle routes.
- Encourage the use of non-motorized transport users in the Bahir Dar city, by conduct different programs such as Bike to Work Day, introduce people to bicycle riding, and temporarily closing streets to motorized traffic and giving exclusive street access to pedestrians, cyclists.
- Aware the society by celebrating the week of walking at the left side, crossing the road at marked or Zebra crossing, thinking traffic accident victims, and education about traffic rules and regulations in the city of Bahir Dar.
- Provide continuous sidewalk, wide enough to support existing pedestrian traffic, on both sides of the road, zebra crossing at the required place, construct over and under pass bridges on major and congested intersection (for example round about around Papyrus hotel and roundabout at st.Giorigis church).
- Integrate with transit (Bike-transit) integration and transit oriented development, public Bike System (PBS) which is automated Bicycle rental systems designed to provide efficient mobility for short trips in the city of Bahir Dar.
- Support bicycle encouragement programs, such as Bicycle Commuter Week and bicycle tourism promotion efforts.
- Identify priority locations for sidewalk improvements that are too narrow, in poor repair, and poorly designed.
- Secured short term and long term parking must be provided at selected destinations like schools, colleges, recreational areas, working areas, shops and market centers etc. to encourage Bicycle users.

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Appendix I

School of Civil and Environmental Engineering

Addis Ababa Institute of technology

Declaration:

The information given will be treated with confidentially and used for academic purpose only.

I. Structured questionnaire for pedestrians or road users.

Respondents Details

1. Age (years) 1. Below 18 2. 18-36 3. 37-55 4. Over 55
2. Sex 1. Male 2. Female
3. Educational level 1. No formal education 2. Primary level 3. Secondary level 4. College and Polytechnic 5. University level
4. Occupation 1. Self-employed 2. Formal employment 3. Daily labor 4. Student
5. What is your preferred mode of transport? 1. Walking 2. Cycling 3. Motor Bike 4. Public transport 5. Personnel car 6. Others_____
6. Mostly available/used modal share of passengers transport system in Bahir Dar city? 1. Walking 2. Cycling 3. Motor bike 4. Public transport 5 personal car 6. Others _____
7. For answer question #6, what is the reason you select this as a preferred mode of transport? 1. Cheap cost/economical 2. Less time 3. More safe 4. Easily Available 5. Specify any other _____
8. What is the purpose of your journey? 1. Work 2. School 3. Shopping and business 4. Recreational and Social 5. Others specify _____
9. How long do you take (minutes) to reach your destination? 1. (1-20 minutes) 2. (21-40 minutes) 3. (41-60) 4. Specify others _____
10. Are you satisfied the time you take? 1. Yes 2. No
11. If you say No what can be done to reduce your journey time?

    _____
12. How would you describe the presence and quality of pedestrian walkway/sidewalk width rating in Bahir Dar city? 1. Excellent 2. Good 3. Satisfactory 4. Poor

13. How would you describe the presence and quality of traffic signs, lights, road marking and pedestrian zebra crossing conditions in Bahir Dar city?

1. Excellent 2. Good 3. Satisfactory 4. Poor

14. Rank the following problems in their order of priority in terms of endangering pedestrian safety?

- Higher speed of vehicles----------
- Not given priorities, to pedestrians----------
- Lack of enforcements----------
- Limited number of properly designed pedestrian crossing -------
- Others (specify) ----------

15. What type of sidewalk obstacles do you get frequently? (You can select more than one), 1. Utility poles 2. Construction materials 3. Vendors 4. Destructed roads

16. How do you rate drivers give priorities to pedestrians as required by law in Bahir Dar city? 1. Excellent 2. Very good 3. Good 4. Poor

17. Which type of road traffic accidents were highly prevailing in Bahir Dar city? You can fill more than once.

- ✓ Motor vehicle with motor vehicle
- ✓ Motor vehicle with bicycle
- ✓ Motor vehicle with Bajaj
- ✓ Motor vehicle with pedestrians
- ✓ Motor vehicle with static object
- ✓ Motor Vehicle with horse drawn cart
- ✓ Horse drawn carts with pedestrians
- ✓ Bajaj with horse drawn carts
- ✓ Bajaj with Bajaj
- ✓ Bajaj with pedestrians
- ✓ Bicycle with bicycle

Other (Specify)

18. What are the solutions to solve the problem of pedestrians and cyclists in Bahir Dar city?
    a. _____
    b. _____
    c. _____
19. What are the potential of non-motorized transport within Bahir Dar city and how can it is exploited?

a) _____
b) _____
c) _____

II. Structured questionnaires about Bicycle transport

Respondents Details

1. Age (years) 1. Below 18 2. 18-36 3. 37-55 4. Over 55
2. Sex 1. Male 2. Female
3. Educational level 1. No formal education 2. Primary level 3. Secondary level 4. College and Polytechnic 5. University level
4. Occupation 1. Self-employed 2. Formal employment 3. Daily labor 4. student _____
5. What is your preferred mode of transport? 1. Walking 2. Cycling 3. Motor Bike 4. Public transport 5. Personnel car 6. Others_____
6. Mostly available/used modal share of passengers transport system in Bahir Dar city? 1. Walking 2. Cycling 3. Motor bike 4. Public transport 5 personal car 6. Others _____
7. For answer question #6, what is the reason you select this as a preferred mode of transport? 1. Cheap cost/economical 2. Less time 3. More safe 4. Easily Available 5. Specify any other _____
8. What is the purpose of your journey? 1. Work 2. School 3. Shopping and business 4. Recreational and Social 5. Others specify _____

9. How long do you take (minutes) to reach your destination? 1. (1-20 minutes) 2. (21-40 minutes) 3. (41-60) 4. Specify others _____
10. Are you satisfied the time you take? 1. Yes 2. No
11. If you say No what can be done to reduce your journey time?

    _____

12. What makes Bicycle transport difficult in Bahir Dar city to drive?
    1. Absence of Bike lane/roads too narrow
    2. No sidewalk/shoulder
    3. Roads too busy/too much traffic
    4. Health issues
    5. Absence of street lights
    6. Destination distance is too far
13. What facility changes would do you recommend to increase Bicycle users in bahir Dar city?
    1. Provide Bicycle facilities (bike lanes, bike parking racks, safe signals and intersections
    2. Improve existing road facilities
    3. Apply laws governing to Bicycles
    4. Initiating Bicycle safety education for drivers
14. In the absence of NMT infrastructural where you ride on your Bicycle
    1. On the carriage
    2. On the sidewalk/walkway
    3. Maneuver through whatever obstacles are on their way
15. What problems or challenges in Bahir Dar city are more encountered when using a Bicycle transport?
    1. Bicycle theft
    2. Parking problem
    3. Traffic accident
    4. Congested traffic
    5. Quality of road

16. Do you get well Bicycle parking facilities at key locations such as bus stations shopping centers, public facilities etc. in the city? 1. Yes 2. No
17. How would you describe the condition of bicycle infrastructure in the Bahir Dar city?
    1. Excellent 2. Very good 3. Good 4. Poor
18. Are there sufficient/enough Bicycle maintenance facilities in Bahir Dar city? 1. Yes 2. No
19. What are the main problems of Bicycle transport in Bahir Dar city?
    a. _____
    b. _____
    c. _____
20. What are the potential of Bicycle transport within Bahir Dar city?

a) _____
b) _____
c) _____

III. Interview with key informants (Transport Engineer, Spatial Planners, Traffic police officers, Geo spatial Engineers etc.).

1. What is the current level of non-motorized transport (NMT) (cycling and walking) within the city of Bahir Dar compared to other modes of transport?
2. What are the challenges and potentials of promotion of NMT within the Bahir Dar city to enhance safety and mobility?
3. What are the major sustainable transportation planning challenges of Non-Motorized Transport within the city?
4. What are the potential of non-motorized transport within Bahir Dar city and how can it is exploited?
5. According to you, who are the key players within the transport sector and what can they do to promote the non-motorized transport,
6. What do you suggest the Bahir Dar city Municipality or other concerned body of the city can do to improve the facility of non-motorized transport within the city?

In the west (Debre Markos) direction

Time	Small car	Bajaj	Mini bus	Large Bus	Bike	Hand cart	Animal cart	Motor bike	Pedestrian
12:00 to 1:00	45	327	97	7	68	11	2	14	1682
1:00 to 2:00	126	865	149	19	93	17	0	36	3264
2:00 to 3:00	103	951	116	14	97	23	6	27	3052
3:00 to 4:00	79	723	108	6	91	25	3	35	2593
4:00 to 5:00	128	560	146	10	80	20	4	24	2980
5:00 to 6:00	96	682	119	6	77	19	7	21	2163
6:00 to 7:00	106	738	158	13	80	21	3	26	2815
7:00 to 8:00	94	806	124	18	79	18	4	23	2234
8:00 to 9:00	84	617	118	16	73	22	2	19	1681
9:00 to 10:00	68	539	134	11	83	19	6	29	1967
10:00 to 11:00	103	814	152	15	82	23	8	35	2618
11:00 to 12:00	92	876	138	22	80	20	4	52	3452
12:00 to 1:00	97	936	133	18	76	24	7	33	2715
1:00 to 2:00	78	611	124	9	61	9	1	18	1852
Total	1299	10045	1816	184	1120	271	56	392	35068

In the North (Gondar) direction

Time	Small car	Bajaj	Mini bus	Large Bus	Bike	Hand cart	Animal cart	Motor bike	Pedestrian
12:00 to 1:00	31	224	83	3	26	6	1	2	958
1:00 to 2:00	194	787	151	33	67	11	0	5	2235
2:00 to 3:00	107	629	148	22	79	21	0	9	2105
3:00 to 4:00	86	593	143	13	62	13	3	10	1654
4:00 to 5:00	76	488	134	0	56	20	0	9	1920
5:00 to 6:00	81	587	136	9	64	14	2	3	834
6:00 to 7:00	114	822	142	28	68	17	2	12	1156
7:00 to 8:00	79	507	121	17	56	10	0	6	931
8:00 to 9:00	70	490	92	6	48	13	3	0	725
9:00 to 10:00	81	502	86	13	92	7	0	7	934
10:00 to 11:00	133	732	121	16	83	12	1	13	824
11:00 to 12:00	168	840	126	27	96	8	4	8	1040
12:00 to 1:00	148	589	108	5	72	13	2	6	1480
1:00 to 2:00	96	178	89	0	43	3	6	12	964
Total	1464	7968	1680	192	912	168	24	102	17760

In the south (Motta) direction

Time	Small car	Bajaj	Mini bus	Large Bus	Bike	Hand cart	Animal cart	Motor bike	Pedestrian
12:00 to 1:00	56	382	58	6	21	28	16	16	854
1:00 to 2:00	124	516	87	12	34	49	11	32	1206
2:00 to 3:00	105	465	72	9	37	56	7	28	1177
3:00 to 4:00	76	412	61	7	26	35	4	21	983
4:00 to 5:00	86	385	74	3	61	21	9	11	1046
5:00 to 6:00	90	328	87	6	41	45	10	31	819
6:00 to 7:00	96	404	80	8	32	40	12	24	759
7:00 to 8:00	87	375	70	5	23	49	2	29	864
8:00 to 9:00	68	314	68	13	39	37	3	16	961
9:00 to 10:00	76	406	52	10	21	52	8	32	1041
10:00 to 11:00	95	393	73	8	32	41	4	33	870
11:00 to 12:00	143	412	86	11	47	47	6	23	1135
12:00 to 1:00	113	345	75	8	25	28	11	28	941
1:00 to 2:00	56	310	63	3	9	34	3	12	752
Total	1271	5447	1006	109	448	562	106	336	13408