Assessing Socio-Economic Impact of Urban Transport Congestion the Case of Addis Ababa Exit and Entrance, from Asera Simint Mazoria - Ashewa Meda

Hayimanot Dejene Guchi

A Thesis Submitted to The department of Urban Planning and Design
School of Architecture and Civil Engineering

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Urban Planning and Design (Specialization in Urban planning and design)

Office of Graduate Studies
Adama Science and Technology University

June, 2021
Adama, Ethiopia

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Declaration

I declare that this thesis/dissertation proposal entitled "Assessing Socio-Economic Impact of Urban Transport Congestion the Case of Addis Ababa Exit and Entrance, from Asera Simint Mazoria - Ashewa Meda" is my own work and has not been submitted to any university for similar purpose. The references used in this proposal are duly recognized by proper citations.

_____ _____ _____

Name of student _____Signature _____ Date

I, the major advisor/supervisor of this research proposal, hereby certify that I have closely advised/supervised the student while developing this proposal and read the draft thesis/dissertation proposal entitled "Assessing Socio-Economic Impact of Urban Transport Congestion the Case of Addis Ababa Exit and Entrance, from Asera Simint Mazoria - Ashewa Meda" prepared under my guidance by Hayimanot Dejene. Therefore, I recommend the submission of the proposal to the department for further review and evaluation.

_____ _____ _____

Major Advisor/Supervisor Signature Date

Approval Page

I, the advisors of the thesis entitled "Assessing Socio-Economic Impact of Urban Transport Congestion the Case of Addis Ababa Exit and Entrance, from Asera Simint Mazoria – Ashewa Meda" and developed by Hayimanot Dejene hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

_____ _____ _____

Major Advisor Signature Date

We, the undersigned, members of the Board of Examiners of the thesis by Hayimanot Dejene have read and evaluated the thesis entitled Assessing Socio-Economic Impact of Urban Transport Congestion the Case of Addis Ababa Exit and Entrance, from Asera Simint Mazoria - Ashewa Meda and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in urban planning and design

_____ _____ _____

Internal Examiner Signature Date

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Chairperson Signature Date

Final approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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School Dean Signature Date

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List of Acronyms

ASTU: Adama Science and Technology University

FHWA: Federal Highway Administration

GRP: Gross regional product

HCM: Highway Capacity Manual

AACRA Addis Ababa City Road Authority

LOS: level of service

ERA: Ethiopian road authority

TH: Through Traffic

TRR: Transportation Research Record

RTA: Road Traffic Accident

ATT: Average Travel Time

AA: Addis Ababa

PCU: Passenger Car Unit

UTPTM: Urban Transport Planning and Traffic Management

RSDP: Road Sector development program

CDP: City Development Plan

PAS: Principal Arterial Street

LC: Local Collector

RC: Residential Collector

HOV: High Occupancy Vehicle

Abstract

Addis Ababa is one of the most central cities in Ethiopia. With the rapid development of the economy in the last three decades, Addis Ababa, like many other African cities, has met some challenges. People spent much more time travelling, and their quality of life was in danger. My thesis includes five parts: introduction of Addis Ababa, theories and instruments on reducing traffic congestion, instruments that have been used in Addis Ababa, and recommendations for Addis Ababa transportation.

Firstly, Addis Ababa" background information was discussed in the first chapter. Population and the number of vehicles can be seen as the main reasons for traffic congestion in Addis Ababa. Also other problems are listed: old road structure, the mingling of different transits, low efficiency of public transit, and poor management.

Secondly, I discussed theories and instruments that had been used worldwide to reduce traffic congestion. Traffic principles were introduced: triple convergence and 'offsetting by growth', which should not be ignored when people were talking about traffic congestion. Then I separated instruments into three parts: physical instruments, market instruments, and regulatory instruments; and I discussed some instruments in these three parts.

Thirdly, my attention was focused on Addis Ababa's efforts to reduce traffic congestion. Since Addis Ababa is in the process of rapid urbanization, physical instruments were used most widely to reduce traffic congestion in Addis Ababa. At last, I listed some conclusions and recommendations for Addis Ababa to reduce traffic congestion, which could be classified as supply-side instruments and demand-side instruments. Transport supply consists of a combination of means that make transportation possible. They can be classified as follows: Infrastructure: roads designed for circulation; Means of transportation: vehicles; and The manner in which both are managed Urban transport supply tends to be categorized according to its capacity, that is, the number of persons who can be transported in a given period of time. Just from the infrastructure standpoint, capacity is usually measured as the number of vehicles that can circulate in a given area in a certain period of time; this parameter is meaningful when analyzing congestion, but it should not be forgotten that what really matters in a city is allowing people to move around satisfactorily.

***Key words**: Traffic congestion, impact of congestion, Total Economic cost of Travel Time traffic congestion.*

CHAPTER ONE

1. Introduction

1.1. Background of the study

Traffic congestion has been increasing in much of the world, developed or not, and everything indicates that it will continue to get worse, representing an undoubted menace to the quality of urban life. Its main expression is a progressive reduction in traffic speeds, resulting in increases in journey times, fuel consumption, other operating costs and environmental pollution, as compared with an uninterrupted traffic flow. (Alberto bull, 2003)

Traffic congestion is a problem in many cities of the World, both developed and developing countries and it is predicted that it will get worse in the future. Urban traffic congestion can be contributed by several factors including a rapid increase in urban population, economic growth, increase in employment opportunities, increase in the number of cars, and the number of peoples using cars, low capacity of transport infrastructure, the road lay out, under investment in road infrastructure, poor management, shortage of off-street parking, signal and equipment failure, non-adherence to traffic regulation, poor urban planning transport. *(Institute of Transport Engineers, 1989)*

Traffic congestion is one of many serious global problems of both developed and developing countries. It always exerts a negative externality up on society. It poses a severe threat to the economy as well as the environment *(Najneen et.al, 2010)*. Congestion become a common characteristic in urban road transportation system of the cities of developing countries which results in high operation cost, loss of time, high delay, high travel time and increase in fuel consumption *(Haregewoin, 2010)*

As modernization and consequently the urbanization moves forward, the use of motorized transport to maintain the socio-economic and physical integration of city increases. The rise in automobile ownership although not yet very significant together with the poor condition of the roads and the poorly functioning traffic system have resulted in high level of congestion particularly at peak hours, where by the probability of occurrence of congestion is very high. Addis Ababa city transport authority report depicts, the vehicle fleet in 2016/17 is estimated to be 524,444 with the average growth of the vehicle increase 30 percent in the year. (transport authority report 2017)

Social impact refers to the effect of an activity on the social fabric of the community and well-being of the individuals and family. In business and government policy, social impact refers to how the organizations actions affect the surrounding community. Social impacts can link to areas such as health and community. The term social problem means a social situation caused by repetitive patterns of social behavior that result in negative consequences and fall short of the affected society's normative ideal. Traffic congestion has various negative impacts ranging from economic loss to adverse environmental and social impacts. Because the roads are free of charge, there will be no financial incentive that would stop drivers from overusing the roads until the point where the road begins to collapse through continuous congestion.

1.2. Statement of Problem

Addis Ababa is one of the cities that are in rapid economic development and most the Ethiopian people exit and enter every single day. These situations create the problems of urban transport congestion in the city is visible in the socio-economy, infrastructures, environment and health. It's associate with increase vehicular queuing and poor accessibility to work and home places especially in the morning and evening hours.

The serious urban transport congestions are observable in times when most workers are going to their work places and workers go back to their home places. Despite the intensive road network expansion in Addis Ababa, road traffic congestion, long queues of vehicular and excessive delay during peak hours at junctions and bottleneck roads have been major problems in the city and traffic congestion delays the passenger and city dwellers along the road. And can lead to drivers and passengers becoming frustrated and engaging in road rage. Deliveries can't arrive on time and to a certain extent; and Reduces productivity and finally reduce economic growth of Addis Ababa city.

Generally, transport in Addis Ababa is chaotic, inefficient, unreliable and dangerous. It negatively affects society especially the urban poor through loss of productivity, inhibiting human development and reducing the quality of life, change in accident frequency and characteristics, increase in air pollutants and emissions, increased vehicle operating costs and increased noise nuisance, increase wastage of time, increase delay, lack of comfort. Accordingly, the above problem, the objective of this thesis is to assess the socio-economic impact of urban transport congestion at Addis Ababa city exit and entrance from Asera Simint Mazoria to Ashewa Meda road segment.

1.3. Objective of the Study

1.3.1 General objective

The general objective of this thesis is to assess the socio-economic impact of urban transport congestion in the case of the Addis Ababa city exit and entrance from Asera Simint Mazoria to Ashewa Meda road segment.

1.3.2 Specific objectives

1. Evaluate the cause of traffic congestion on the selected road.
2. Provide well-accessed traffic flow and well design road network among the study areas.
3. Prefer some planning options to ease Vehicular Traffic congestion in Asera Mazoria to Ashewa Meda.

1.4. Research questions.

1. What are the main causes of traffic congestion in the Addis Ababa exit and entrance?
2. Is congestion impact socio-economic activities?
3. How to measure and analysis of traffic congestion?
4. What are the possible solutions to alleviate traffic congestion in the research area?

1.5 Significance of the Research

Nowadays the impact of traffic congestion in study areas is a big issue which currently occurs in the day- to- day activities and it has a serious effect on the socio-economic impact of once country development so, without a doubt the research on the socio-economic impact of urban traffic congestion has a wide range of significance for both the researcher and city administer.

The researcher will have a better understanding regarding the determination of congestion. The road traffic congestion measures analysis shows the existing situations and using these result; we can predict what will happen in the future, due to the fact that every person living working or even who made a visit within the city is affected or touched differently by the existing road traffic congestions, leaving aside its general impact on peoples‟ socio-economic impact in the city. It has expecting to show how the traffic congestion has affected the residents of Addis Ababa city socially and economically.

The research provided relevant recommendations and suggestions in accordance with the nature of the findings as well as relating them to the current national transportation policy. Also, the research pin pointed some areas which require future investigation on the future on condition that there will be a gap between it and other studies on the problem.

Finally, the research will be minimizing the level traffic congestion problem of Road Segment. The Study will help the researcher to fulfill the partial requirement for being awarded the degree of Master of Science in urban planning and design at Adama Science and Technology University.

1.6 Scope of the research

This study is conducted in one of Addis Ababa city exit and entrance, at ***Kolfe Keraniyo Sub City from 18 Mazoria to Ashewa Meda*** along the street. It is almost all socio-political and economic sectors being public, private and international. These study areas cover Approximately 2 km long along the street. Type and cause of traffic congestion, strategies to alleviate congestions will be analyses in this study.

In general, this thesis was conducted assessing the socio-economic impact of road traffic congestion in the case of Asera Simnt Mazoria to Ashewa Meda Road Segment. The specific objective is to focus only on the analysis of delay; socio-economic effects of traffic congestion on the communities. Finally the studies prepare appropriate strategic plan and design for the study areas.

1.7 Limitation of the Study

The limitation of the research of the study carried out the following:

- The research is carried out only for the Asera Simnt Mazoria to Ashewa Meda urban street roads due to heterogeneous traffic flow, road condition of and driving characteristics, insufficient secondary data of vehicle volume.
- The proposal Wright, the researcher faced a number of challenges like the necessary data, tools of data collection, Unavailability of data resources.
- During the questionnaires, many of the peoples who were initially approached to answer questions were not comfortable and therefore not cooperative. Due to the nature of the traffic congestion, many of the passengers were very tired, exhausted and sometimes angry and disappointed. It was therefore not an easy task convincing them to answer the questions. Some of the respondents refused to answer the questions and as such were replaced.

1.7 Organization of the thesis

The thesis is organized in five chapters, references and an appendix. Chapter one covers an overview of transportation problems in relation to traffic congestion in the Kolfe Keranio sub city. Chapter two reviews the related literatures about transportation problems in general. It also includes summaries of prior research on urban transportation planning modeling.

Chapter three covers the methodology of the study, which includes ways to quantify transportation system performance, particularly traffic congestion. Chapter four covers data collection, analysis and discussion. Chapter five gives the summary and conclusion of the study. It also makes some recommendations for future studies in this field.

CHAPTER TWO

Literature Review

2.14 Definition of Traffic Congestion

The definition of congestion is imprecise and is made more difficult since people have different perceptions and expectations of how the system should perform based on whether they are in rural or urban areas, in peak or off-peak, and as a result of the history of an area *(Bertini, 2005).*

There is no consistent definition of congestion in terms of a single measure or set of measures that considers severity, duration, and spatial extent. Measures related to travel time and speed are the most flexible and useful for a wide range of analyses (R. Narayanan et. al.2003). For instant, The Federal Highway Administration (FHWA) defines traffic congestion as: "the level at which transportation system performance is no longer acceptable due to traffic interference."

According to Lomax et.al, 1997, traffic congestion definition depends on the understanding of the road users. Based on this the definition is divided as congestion and unacceptable congestion and it is defined as:

- ✓ Congestion is travel time or delay in excess of that normally incurred under light or free-flow travel conditions.
- ✓ Unacceptable congestion is travel time or delay in excess of an agreed-upon norm.

Traffic congestion refers to incremental delays and vehicle operating costs caused by interactions among vehicles, particularly as traffic volumes approach roadway capacity *(Todd Litman).* Generally definitions of traffic congestion generally fall in to two major categories. These are definitions based on the cause and the impact of traffic congestion.

Traffic congestion may be recurrent and nonrecurring. Recurrent congestion occurs at the same place at the same time every weekday or weekend. It is a capacity problem and is logically combated with raising roadway capacity. Nonrecurring congestion results from incidents such as accidents, inclement weather or road way maintenance *(Lomax et.al, 1997).*

2.15 Source and Impact of Traffic Congestion

In 2010, Mc Groarty explained the source of traffic congestion varies with the congestion type. Hence, recurring congestion occur when the volume of traffic exceeds the roadway capacity while nonrecurring congestion occur mostly by crashes and incident, vehicle breakdown, road

construction activities, special events etc. Similarly, Lomax et.al, 1997, supports traffic congestion usually result when the road system is unable to accommodate traffic, conflict among the different type of traffic and traffic control improper uses.

European Conference of Ministers of Transport suggested the sources of traffic congestion as a reduction in road capacity caused by an unplanned event, for example, an accident with wrecks blocking a lane; a planned reduction in capacity due to construction or maintenance of the lane, and finally a traffic demand higher than the maximum flow capacity as per European conference of ministers of transport.

2.16 Congestion Indicator

One of the most critical needs in traffic engineering is a clear understanding of how much a given facility can accommodate and under what operating conditions. As congestion is a relative measure unlike the other traffic flow parameters and it is defined on the road user's feedback on how the transports system is operating at a given period of time; it is essential to define or have indicators of the presence of congestion in the system. For example, if the road is a multilane highway. It has its own characteristics.

According to (Highway Capacity Manual)HCM, a Multilane highway can be characterized by three performance measures:-

- Density in terms of passenger cars per kilometer per lane,
- Speed in terms of mean passenger car speed, and
- Volume to capacity ratio.

Each of these measures is an indication of how well traffic flow is being accommodated by the highway. Above all, travel time and speed is a common indicator of the occurrence of congestion that is when a given vehicle goes at a lower speed with forming a queue and increasing of the average travel time. These two require more effort to measure than the traffic volume counts that currently provide the basis for most congestion estimation procedures.

2.17 Types of Congestion

The two types of congestion are outlined as

1) **Recurrent congestion**.

Occurs mainly when there are too many vehicles wanting to use the road at the same time Recurrent congestion typically occurs during weekday morning and afternoon peak periods, when most people go to work and return home at around the same time. In large urban areas, the peak periods can range from 7:00 to 9:30 a.m. and from 3:30 to 7:00 p.m. In smaller urban areas, the peaks may have a shorter duration (one or two hours). Of interest is the growing recurrent congestion that occurs during off -peak periods (i.e. during other weekday hours, and even on weekends). This reflects, in large part, rapid growth in off-peak travel (off-peak travel is growing faster than peak-period travel in some areas)

2) **Non-recurrent congestion.** Is the other main source of traffic congestion? Non recurrent congestion is associated with random conditions or special and unique events, such as traffic incidents, truck spills, accidents, work zones, unusual or disruptive man oeuvres by individual drivers, irregular facility maintenance operations (e.g., seasonal street cleaners), and adverse weather and special events. Because of the random nature of this type of congestion, non-recurrent congestion is more difficult to predict and address.

2.18 Cause of Congestion

The proximate causes of congestion are numerous, e.g. too many vehicles for a given road's design or intersection capacity, dynamic changes in roadway capacity caused by lane-switching and car-following behavior. They are also always linked to other indirect factors such as land-use patterns, employment patterns, income levels, car ownership trends, infrastructure investment, regional economic dynamics, etc.

However, I can identify two principal, broad categories of causal factors; micro-level factors (e.g. those that relate to traffic "on the road") and macro-level factors that relate to the overall demand for road use. In this context, congestion is "triggered" at the "micro" level (e.g. on the road), and macro-level. The most common example is the physical use of roads by vehicles. When traffic demand is great enough that, the interaction between vehicles is slow the speed of the traffic stream, which results in some congestion.

2.19 Consequence of Congestion

Increased travel time is the most direct consequence of road traffic congestion. But it is not the only cost. Congestion incurs both tangible and intangible costs to individual road users as well as our society. For example, apart from time wasted when people are caught in congestion, low mobility adversely affects the business sectors.

When goods or services cannot be delivered on time, the business sectors need to incur additional inventory costs and logistics costs. As a road reaches its capacity, each additional vehicle imposes more total delay on others than they bear, resulting in economically excessive traffic volumes. Congestion tends to increase travel time, decrease productivity, arrival unreliability, fuel consumption, pollution emissions and driver stress, and reduce life satisfaction.

2.20 Impact of Congestion

Congestion involves queuing, slower speeds and increased travel times, which impose costs on the economy and generate multiple impacts on urban regions and their inhabitants. Impacts on quality of life, stress, and safety as well as impacts on non-vehicular road space users such as the users of sidewalks and road frontage properties. Policy-makers should give serious attention to evaluation methodologies include an assessment of these impacts as well as take into account broader considerations such as the type of cities people want. This study assesses congestion, congestion cost, and their impact on different types of transportation. The costs of traffic congestion have received increasing attention in recent years.

2.20.1 Longer commuting.

- ✓ On par with congestion people are spending an increasing amount of time commuting between their residence and workplace.
- ✓ An important factor behind this trend is related to residential affordability as housing located further away from central areas (where most of the employment remains) is more affordable.
- ✓ Therefore, commuters are trading time for housing affordability.
- ✓ However, long commuting is linked with several social problems, such as isolation, as well as poorer health (obesity).

2.20.2Public transport inadequacy

- ✓ Many public transit systems, or parts of them, are either over or under-used.

- ✓ During peak hours, crowdedness creates discomfort for users as the system copes with a temporary surge in demand.
- ✓ Low ridership makes many services financially unsustainable, particularly in suburban areas.
- ✓ In spite of significant subsidies & cross-financing (e.g. toll (tax/charges)), almost every public transit systems cannot generate sufficient income to cover its operating & capital costs.

Connectivity: - Public transit systems are often independent of other modes & terminals.

- ✓ It is consequently difficult to transfer passengers from one system to the other.

Competition:-In view of cheap & ubiquitous (everywhere) road transport systems, public transit faces strong competition.

- ✓ The higher the level of automobile dependency, the more inappropriate the public transit level of service.
- ✓ The public service being offered is simply outpaced by the convenience of the automobile.

2.20.3 Difficulties for non-motorized transport

- ✓ These difficulties are either the outcome of intense traffic, where the mobility of pedestrians, bicycles and vehicles is impaired,
- ✓ but also because of a blatant(deliberate) lack of consideration for pedestrians & bicycles in the physical design of infrastructures & facilities

2.20.5 Loss of public space

- ✓ The majority of roads are publicly owned & free of access.
- ✓ Increased traffic has adverse impacts on public activities which once crowded the streets such as markets, agoras, parades (carnival) & games, and community interactions. These have gradually disappeared to be replaced by automobiles.
- ✓ Traffic flows influence the life & interactions of residents & their usage of street space.
- ✓ More traffic impedes/hinders social interactions and street activities. People tend to walk and cycle less when traffic is high.

2.20.6 Freight distribution

- ✓ Globalization and the materialization of the economy have resulted in growing quantities of freight moving within cities.

- ✓ As freight traffic commonly shares infrastructures with the circulation of passengers, the mobility of freight in urban areas has become increasingly problematic.
- ✓ City logistics strategies can be established to mitigate the variety of challenges faced by urban freight distribution.

2.20.7 Road & Parking Facility Costs

- Most communities spend huge money annually on roads, traffic management services (such as traffic planning, policing & emergency services) & parking
- Strategies that reducing these costs (or at least the growth in these costs) can be considered to provide a benefit.
- For example, a benefit of transit services improvements is that shifting travel from driving to transit it reduces the need to provide parking facilities at destinations.

2.20.8 Community Livability

- Community livability refers to the environmental & social quality of an area as perceived by residents, employees, customers & visitors.
- This includes crash risk, noise, local pollutants (e.g., dust, particulate matter), preservation of unique cultural & environmental resources (e.g., historic structures, mature trees, and traditional architectural styles), the attractiveness of streets, opportunities for recreation & entertainment, & the quality of social interactions, particularly among neighbors.
- A livable community directly benefits people who live in, work in or visit the neighborhood, increases property values & business activity, & it can improve public health and safety.

2.4 Congestion Measures

Mobility Measures

These are the five most common measures for mobility:

1. **Volume-to-Capacity Ratio (V/C Ratio):** the volume divided by capacity. For the Level of Service (LOS) calculations, volume is often taken to be the 30th yearly highest.
2. **The Level of Service (LOS):** a grade from A to F – with a being free flow and F being very congested – that indicates how well the roadway or intersection is serving its intended traffic. LOS is based on a volume to capacity (v/c) ratio and has long been used as the primary measure of congestion for planning purposes. See the Highway Capacity

Manual for more details.

3. **Travel Time Index:** ratio of average peak travel time to an off-peak (free-flow) standard, in this case 60, mph for freeways. For example, a value of 1.20 means that average peak travel times are 20% longer than off-peak travel times.
4. **Travel Delay:** the amount of extra time spent traveling due to congestion.
5. **Percent of Congested Travel:** the congested vehicle-miles of travel divided by total vehicle miles of travel. A relative measure of the amount of travel affected by congestion.

2.10. Traffic Congestion Mitigation Strategies

Many researchers identified different traffic congestion mitigation measures depends on the causes and the type of congestion. From those researches Managing Urban Traffic Congestion, 2007 conclude there is no prescribe specific congestion management strategies since the appropriateness and applicability of these depend largely on the local context. The report suggests three strategic congestion management principles that should serve to guide policies in this field.

Ensure that land use planning, and the community objectives it embodies, is coordinated with congestion management policies;

Deliver predictable travel times; and

Manage highly trafficked roadways to preserve adequate system performance.

Transportation engineers and planners of Cambridge Systematic, Inc. & Texas Transportation Institute, has developed a variety of strategies to deal with congestion. The strategies can be grouped in to three as follows and each group has key strategies to address congestion:

1. Adding more capacity for highway, transit, and railroads

Key Strategies to Address Congestion:

Adding travel lanes on major freeways and streets (including truck climbing lanes on grades)

Adding capacity to the transit system (buses, urban rail, or commuter rail systems) Closing gaps in the street network

Removing bottlenecks

Overpasses or underpasses at congested intersections

High-occupancy vehicle (HOV) lanes

Increasing intercity freight rail capacity to reduce truck use of highways

2. Operating existing capacity more efficiently

Key Strategies to Address Congestion:

- ✓ Optimizing the timing of traffic signals
- ✓ Faster and anticipatory responses to traffic incidents
- ✓ Providing travelers with information on travel conditions as well as alternative routes and modes
- ✓ Improved management of work zones
- ✓ Geometric improvements to roads and intersections
- ✓ Converting streets to one-way operations
- ✓ Access management.

3. Encouraging travelers to use the system in less congestion-producing ways

Key Strategies to Address Congestion:

- ✓ Programs that encourage transit use and ridesharing
- ✓ Curbside and parking management
- ✓ Flexible work hours
- ✓ Telecommuting programs

In 2010, Haregewoin summarized the traffic congestion relief strategies on the Total-Ayer Tena road segment which is found in Kolfe Sub-city, Addis Ababa. Based on the research congestion relief strategies depend or vary with the existing conditions of the area. Some of the strategies are following;

Apply flextime working schedules

Improve capacity of

Experiencing adequate parking arrangements

Implement transit-oriented development and improved access management

CHAPTER – THREE

3.0 Methodology

3.1 Introduction

The methodology worked for research work is the serious aspect for ensuring the proper consequence which aligns with the objective or the research question, rose. Hence, this part of the thesis discusses the methodology used and the cause for the selection of the methods to address the research problem stated earlier in the previous two sections.

3.2. Description of Study Area

This study is conducted in ***Kolfe Keraneo sub city***, simply called ***Kolfe***. Kolfe is one of the 11 sub-cities of Addis Ababa, the capital city of Ethiopia and located on the western edge of the Addis Ababa city.

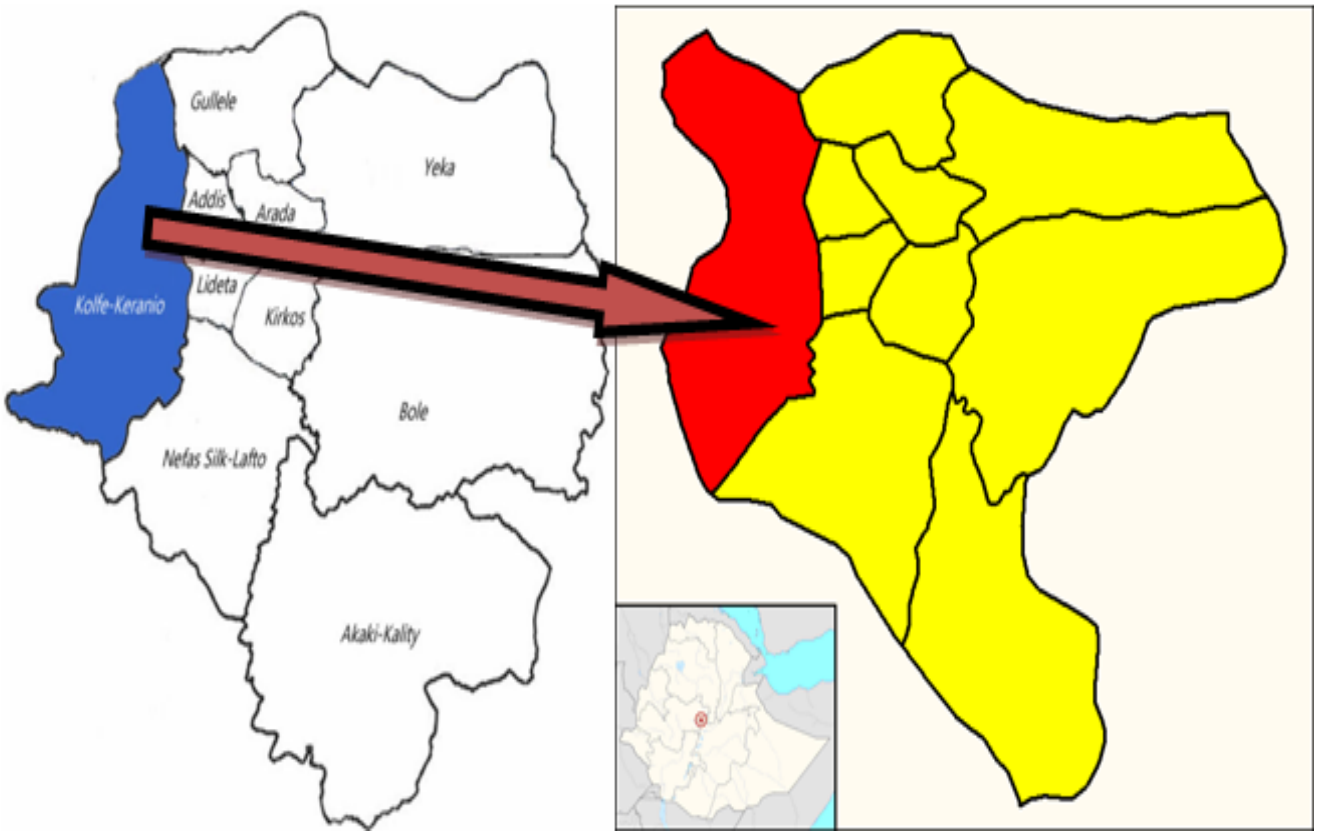


Figure 1: The Addis Ababa and Kolfe Keranio Sub City Maps

Figure 2 Existing Structural Plan of Kolfe keraneo sub city

The study area is one of the main Addis Ababa exit and entrance to the city at ***Kolfe keraniyo sub city from 18 Mazoria to Ashewa Meda*** along street. The length of the study area road section is approximately 2 km along urban street and shown below the table.

Selected Road	Length (m)	Travel Time (sec)
Asera 18 mazoria to Anfo roundabout	1.5km	7:00 AM –6:00 PM
Anfo Roundabout to Ashewa meda	500m	7:00 AM –6:00 PM

Table 1 Length of taken road segment

It is considered as one of the semi-peripheral parts of the city recognized for its informal business activities. According to the former Administrative Structure of Addis Ababa; the Kolfe area encompasses *Kebele* 9, 10 and 11 from *Woreda* 24 and *Kebele* 3, 4, 5, 6, 7 and 8 from *Woreda* 25. Geographically, the Kolfe area covers locations stretching from the Dutch Embassy to the General Wingate High School area. The *General Wingate* area in the north, the *Mesalemia* area in the east and the *Torr-Hayloch* area in the south border Kolfe.

The Kolfe area is subdivided into several of neighborhoods called *Sefer* and the residents identify the small physical units by different names. The most famous ones are :(sub-city profile).

- ***Atena Tera,*** literally "***Timber area".*** It was famous for serving as a market place for timber and other wood products used for construction purposes.
- ***Lekuanda*** Literally "butcher" an area where meat is sold at low prices.
- ***Taiwan*** A market place for selling new and cheap clothes that is mostly imported through unofficial trade routes from countries as far away as Taiwan.
- ***Chereta*** Literally "auction", it is a particular location near the final terminal of Bus No.18.

3.3 Research Approach

The research approach in this thesis involves both *quantitative and qualitative approaches*. Quantitative data and analysis were used to determine the total congestion cost, traffic volume analysis, average travel time analysis, delay measures and level of service of urban segments.

A qualitative research methodology covers a number of alternative techniques, including questionnaires and a review of a secondary data source. A direct field measurement was the main sources of quantitative data. Furthermore, qualitative data from the questionnaire were also used to decide whether the congestion in the segment is an impact or not and to assess other related parameters.

3.4 Types and Sources of Data

In order to test the specific objective of the study, data have been collected from primary and secondary sources. The primary data obtained through questionnaires of occupiers involved in the study. This is the type of data which are collects through questioner with respondents. Questionnaire is a series of questions, each providing a number of alternative answers from which the respondents can choose. Hence questionnaire can be considered in general terms in which each person is asked to respond to the same set of questions in a predetermined order.

3.5 Methods of Data Collection and Equipment

3.5.1 Primary data

3.5.1.1 The primary data are collected using the following techniques:

- ✓ Questionnaires
- ✓ Manual traffic volume counts
- ✓ Passenger car unit
- ✓ Manual travel time measure
- ✓ Field measures

3.5.1.2. Questionnaires were distributed randomly for road users (taxi drivers, private car owners, public transport users) to gather information on the awareness of the road users about traffic congestion at a major intersection in the city, possible causes of congestion and to identify the most congested intersection.

3.5.1.3 Manually traffic volume counts and travel time data were collected using paper method on the selected intersection and approaches for the traffic volume count and travel time data respectively.

3.5.1.4 Passenger car unit_ In developing countries like Ethiopia, road traffic congestion is heterogeneous in nature. One of the methods used to convert heterogeneous traffic in to equivalent homogeneous one is by using the PCU factor. The Present roadway and traffic conditions at both intersections were observed and analyzed. Using the present traffic data, by adopting Time Headway Approach, new PCU values were developed.

3.5.1.5 The term Passenger Car Equivalent (PCE) was first introduced in the 1965 Highway Capacity Manual. Today, the definition remains relatively unchanged as "The number of passenger cars that are displaced by a single heavy vehicle of a particular type under prevailing roadway, traffic, and control conditions".

3.5.1.6 Field measure has been done to collect data on the geometrical features of the junction for the determination of the level of services of the intersections. These include the number of lanes, lane width, and configurations of lanes, grade, and width of the median.

3.5.2 Secondary data

Secondary data means data are already available and published. They refer to the data which have already been collected and analyzed by someone else. It also used to unpublished thesis were adapted. Thus, secondary data provide second-hand information and include both raw data and published ones. It includes books, journal articles, newspapers, reports and publications of various associations and organizations as well as other documentary reviews from the internet.

As secondary data, Traffic accident data are collected from Addis Ababa City profile and Kolfe Keraneo Sub-City Police Commission for the period July 2007 to June 2011(5 years), which was the latest data available at the time, for the analysis of the cost of congestion.

3.5.3 Research design

This section addressed the plan, structure, and strategy of investigation of issues related to the socio-economic impact of urban traffic congestion in the case of Addis Ababa city exit and entrance from 18 Mazoria to Ashewa Meda road segment. The plan outline, while the strategy shows the means by which the research is executing and the methods adopted in data collection and analysis.

The methods are followed the design in such a way that the key questions of the research will be answered properly. First, Information on the socio-economic and demographic characteristics (such as sex, age, education, types of occupation, and position, impacts of social, economic, and political problem, impacts of result delay and wastage of time, wastage of time, health and environmental pollution effect, psychological effect, led to the accident, operating cost, and just in case time and extra transportation cost etc.) of the impact of urban traffic congestion on socio-economic activities are generating through questionnaire administration.

The questionnaire is administering to public societies, private societies, students and drivers who formed the population using random sampling and judgmental sampling techniques. Second, to estimate the proportion of traffic congestion one major traffic bottlenecks is selecting the major roads in the study area. The exercise was carried out for three alternate days (i.e. Monday, Wednesday and Friday). The peak hour traffic study was particularly useful. Because it provides important information concerning the maximum traffic loads imposed upon the street network. Data collection was started every morning at (8:30AM – 10:00AM) and after noon (4:00PM – 6:00PM).

3.6 Methods of data analysis

The process of data analysis aims at determining whether the questionnaires support the research questions that are formulate before going into the field to collect the information. With regards to this study, the data collect edited for accuracy and completeness before they are subjects to analysis.

Descriptive statistics were used for and describe by frequency *tables, average, one-way analysis of variance and charts to summarize the data for better analysis*. The questionnaires were prepared on the socio-economic impact of urban traffic congestion was done using micro soft word and excel 2007. In analyzing the data, based on answers from different respondents, field's

measurement and information obtained from documents are thoroughly check out and compared to establish their validity. Analysis of data is basically based on the number sample size using scaling methods.

This paper main method of analysis statistics was an analysis of variance. The demography analysis can be described by descriptive statistics like percentage and graphs. One way analysis of variance is in statistics a technique that can be used to compare means of two or more samples. Finally, we can analysis of the total travel time of economic cost of congestion and delay using excels.

3.5 Description of Selected Study junction

In the study area there is a number of intersections with a different type. Due to time and COVID 19 pandemic, the researcher decided to take only one intersection for further analysis. To do so the questionnaire was distributed to the population to participate in the selection of the most congested intersection.

The intersections are listed

No	junction Name	Type of junction
1	Asera simint mazoria (18)	4 legged junction

Table 2: Name and Type of Major Intersections in the Research Area

3.5.1 Description of the Asera Simint Mazoria (18) Intersection

According to the result of the questioner, Asira Simint Mazoria is the most congested intersection and it's the one of Addis Ababa entrance and exit in the sub-city. The intersection has 4 approaches namely, *Wingate Approach, Torayiloch Approach, Autobus Tera Approach and new ambo Approach*. Plain view of the intersections is shown in figure 12.

Figure 3: Asera Simint Mazoria intersections

According to Lomax et.al, 1997 report the level of traffic congestion highly depends on the perception of different road users. Considering this the researcher tried to check the perception of different road users with the help of questioner.

The questioner contains two parts;

Part-I:

- General Information and
- Helps to check whether the questioner is distributed to all road users.

Part-II:

- Respondent's Perceptions toward traffic congestion in Kolfe Keraneo sub-city.
- Is the main part of the questioner which tells us to know Perceptions of road users toward Traffic congestion in Kolfe Keraneo sub-city?

3.5.1.1. Traffic Volume Count

Traffic volume studies are conducted to determine the number, movements and classifications of roadway vehicles at a given location. These data can help identify critical flow time periods, determine the influence of large vehicles or pedestrians on vehicular traffic flow or document traffic volume trends.

The length of the sampling period depends on the type of count being taken and the intended use of the data recorded. For example, an intersection count may be conducted during the *peak flow period*. If so, a manual count with *15-minute* intervals could be used to obtain the traffic volume data.

For the analysis of LOS traffic volume has been counted on each junction. This is done by considering a different type of vehicles and movement mechanism. To get the accurate result it is significant to count at least for 7 days but due to *COVID 19 pandemic* and *time constraint*, the count was done only for three days.

These days have been selected on the basis of information collected from the traffic police commission. According to the traffic police office mostly Fridays have the highest volume due to market day at Merkato largest market center in Addis Ababa and Friday is a day most people's come to Anwar mosque for religious purposes.

The researcher chose Wednesday randomly to consider the days with low traffic volume. From this day's Wednesday traffic count has been rejected due to multiple errors on the first

Wednesday count. Finally, Friday's traffic volume is found to be higher than Wednesdays except for two approaches. Therefore, I took Friday's traffic volume count for the analysis purpose.

The traffic volume count was made for 10 hours starting the morning 8:30 AM to the evening 6:30 PM at 15 minutes intervals. The vehicles were counted in the category as cars and taxis, 4WD, minibus taxis, Mid-Bus, and standard Bus, Light, Medium and Heavy commercial or truck vehicles. The total traffic volume for each approach is summarized in the Table 6 below for both Wednesdays and Friday count.

Traffic Volume 18 Mazoria Junctions In Time Interval

	Time interval	**AutobusTera approach**	**New ambo approach**		**Winget approach**		**Tor Hyiloch Approach**	
		Has one median	Right median	Left median	Right median	Left median	Right median	Left median
total	8:30-8:45AM	250	100	195	235	510	352	320
	8:45-9:00AM	350	153	250	542	192	542	250
	9:00-9:15AM	210	200	140	180	220	195	200
	9:15-9:30AM	180	240	180	190	150	110	210
	9:30-9:45AM	240	220	190	170	235	140	120
	9:45-10:00AM	320	155	210	255	98	147	110
	10:00-10:15AM	260	100	200	200	90	254	120
	10:15-10:30AM	220	250	140	100	110	235	320
	11:00-11:15AM	105	135	21	130	250	215	125
	11:15-11:30AM	140	220	270	210	435	320	165
	11:30-11:45AM	255	235	115	440	150	130	119
	11:45-12:00AM	54	141	90	50	125	130	65

Figure 6 Traffic Volume 18 Mazoria Junctions in Time Interval

Total Traffic Volume Asira Simint Mazoria for all Approaches`

Asera Siminit Mazoria Junctions								
	Date	**Autobus Tera approach**	**New ambo approach**		**Winget approach**		**Tor ayiloch Approach**	
		One way road	**Right road**	**Left road**	**Right road**	**Left road**	**Right road**	**Left road**
Total	15/01/2021	9500	1050	7500	5623	3510	8562	3250
	18/01/2021	7523	7253	9250	6542	1952	5642	2250
	20/01/2021	9623	8750	8850	7980	10102	7510	8500

Table 3: ***Total Traffic Volume for all Approaches***

3.5.1.2 Travel Time Data

Travel time or the time required to cross a route between any two points of interest, is a fundamental measure in transportation. There exists different method for the determination of travel time. Accordingly, the pen and paper technique requires a driver and a recorder, one or two stopwatches, data collection forms and a test vehicle. The test vehicle is driven along the study route throughout the time period of interest.

The recorder starts the first stopwatch as the driver passes the first checkpoint, recording the cumulative elapsed time at subsequent checkpoints on the field sheet. A second stopwatch may be used to record the amount of delay time incurred by the test vehicle when slowed or stopped (0 to 8 km/h, or 0 to 5 mph), also noting the cause of the delay.

This procedure is followed through the entire course until the time at the final checkpoint is recorded. Several runs are usually made on the same route, requiring the test vehicle to return to the starting point. Data is typically collected on the study route in the reverse direction with little or no additional cost. The stop watches are reset, a new field data collection sheet is prepared and the above procedure is repeated until the end of the study time period.

For this research, travel time has been measured manually using stop watch by fixing the length in which the vehicle is travelling to determine congestion measures. To perform this first the researcher had selected only one approach with the highest traffic volume for each intersection except for Asera Simint junction. Finally 8 samples have been conducted for 30-min and the raw data for the travel time of each approach are summarized in Table

	Travel Time in (min)									
	Asera Simint Mazoria Intersections									
	Awutobis Tera approach					**New ambo approach**				
Time	**Length=200m**				**ATT**	**Length=200m**				**ATT**
7:30-:45AM	15	14	14.5	16	14.8	18	15.5	15	19.5	17
7:45-8:00AM	22	16.5	14	16	15.4	15.5	17	17	17	16.6
8:00-8:15AM	30	16	18	18	16.5	15	18	18	14	16.3
8:15-8:30AM	19	16	16	19	16.6	16.5	15	17.5	19	17
8:30-8:45AM	18	17	16.5	16	16.8	15	16.5	14	16	14.3
8:45-9:00AM	17.5	15	17.5	18	16.8	14	18	14	18	16
9:00-9:15AM	18	16	19	15	17	18	14	19	8	17.3
9:15-9:30AM	16	19	16	18	17.3	16	17.5	17	16	16.6
11:00-11:15AM	18.5	17.5	19	17	18	14	16	19	16.5	16.4
11:15-11:30AM	18.5	19	15	15.5	17	16	18	15.5	19	17
11:30-11:45AM	17	19	15	16	16.8	16.5	18	16	17.5	17
11:45-12:00AM	19	10.5	15	14	17	14.5	17.5	16	16	16

Table 4*: *Total Traffic Volume for awutobis tera and new ambo Approaches`

	Travel Time in (sec.)									
	Asera Simint Mazoria Intersections									
	Torayiloch approach					Winget approach				
Time	Length=200m				ATT	Length=200m				ATT
7:30-7:45AM	12	16	30	17	18.6	19	15.5	15	19.5	17.3
7:45-8:00AM	15	22	24	16	19.3	16.5	17	20	11	16
8:00-8:15AM	33	21	18	18	22.5	15	18	18	14	16.3
8:15-8:30AM	19	7	17	19	15.5	16.5	15	17.5	19	17
8:30-8:45AM	16	27	13.5	20	19.13	15	16.5	14	16	14.3
8:45-9:00AM	13	17	11.5	17	14.6	14	18	14	18	16
9:00-9:15AM	18	20	13	15	16.5	18	14	19	8	17.3
9:15-9:30AM	16	12	16	18	15.5	16	17.5	17	16	16.6
11:00-11:15AM	19.5	16.5	19	17	18	14	16	19	16.5	16.4

11:15-11:30AM	18.5	15	15	15.5	17	16	18	15.5	19	17
11:30-11:45AM	14	14	18	16	16.8	16.5	18	16	17.5	17
11:45-12:00AM	11	9	15	14	17	14.5	17.5	16	16	16

Table 5*: *Total Traffic Volume for torayiloch and winget Approaches

During travel time data collection, the data collector location is very significant especially when the method of data collection is using stop watch by fixing the length of the road. This is due to the length that I fix should be visible for the data collector. The selected locations for all intersections are on buildings located at the mid points of the length fixed. These locations are described in the Figure 13.

Figure 4: ***Asera Simint Mazoria intersections in both directions***

3.5.1.3 Passenger Car Unit

Diverse types of vehicles in a traffic stream have different characteristics like width, length and height and sometimes they produce a problem for other vehicles, so for expressing highway capacity a unit is used called passenger car unit. A passenger car unit is essentially the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car.

According to *Ahmed, 2009*, several approaches to estimate PCU values have been used. The most commonly applied approaches are the constant volume-to-capacity ratio approach and the headway approach. The constant volume-to-capacity ratio approach was developed based on the

output of a multilane freeway simulation model developed at the Midwest Research Institute. PCU values were based on mixed traffic volumes that consumed the same proportion of roadway capacity (produced the same volume-to- capacity ratio) as PC-only volumes. The constant volume-to-capacity ratio approach was appropriate for calculating PCUs when LOS was a consideration for PCU calculation. But it is not applicable to the current procedure, which estimates PCU only under a steady-state condition that is why headway approaches is used for the determination of PCU for this research.

PCU=hi/hc

Where: PCU=passenger car unit

hi= headway of i-th vehicle

hc= headway of passenger car

Then headways have been collected for each type of vehicles considering three cases; morning, midday, and evening peak period and the sample size is taken was the same with travel time sample size shown in the travel time section. The headways are presented as follow in table 10

HEADWAY (Second) Torayiloch and Winget Approaches										
Time	Morning Peak Period									
	Car & Taxi	Cycle	Two wheel	Bajaj	4-WD	Mini Bus	Medium bus	Std. Bus	Medium Trucks	Large Trucks
1	4	9.00	4.30	5.2	1.5	6	6.6	4	4.2	7.30
2	5.2	8.90	5.10	7.6	2.9	7	7.4	5	7.4	8.90
3	3.6	9.70	4.10	4.5	2.4	5.7	4.3	7.3	4.4	8.50
4	4.30	7.90	3.90	6.9	7.5	6	8.2	6	8.3	8.20
5	4.10	6.80	4.60	4	4.5	6	6.1	6	8.2	9.00
Time	Mid-day Peak Period									
1	7.20	5.30	6.10	5.6	9	5	7.2	5	8.4	8.1
2	3.60	8.60	4.00	6.6	5	4	8.6	8	3.6	5.3
3	5.10	5.70	4.60	3.4	4	7	6.5	6	6.6	6

4	8.20	5.30	3.90	6.2	3	5.5	7.7	2	2..7	7.1
5	4.00	7.30	5.80	4	6	6	8	4	7	6.2
Time	Evening Peak Period									
1	3	2	4	2	6	3.2	6.3	7	1	7
2	1	3.1	2.1	3.3	5	5	4.3	5	2	1
3	8	6.5	0.9	4.6	6.5	2	7.4	5	4	6
4	3.3	2.4	5	7	4	7	4	3	7	5
5	4.4	5.8	5.9	5.4	1.2	3.2	2	1	2	7

Table 6: ***headway (second) for Torayiloch and Winget Approaches***

HEADWAY (Second) Awutobis tera and New ambo Approaches										
Time	Morning Peak Period									
	Car & Taxi	Cycle	Two wheel	Bajaj	4-WD	Mini Bus	Medium bus	Std. Bus	Medium Trucks	Large Trucks
1	5	8	4	8	7	3	6	4	4.2	7.30
2	6	9.	8.10	7.6	3.9	6	7.4	5	7.4	8.90
3	3.6	9.70	4.10	4.5	2.4	5.7	4.3	7.3	4.4	8.50
4	4.30	7.90	3.90	6.9	7.5	6	8.2	6	8.3	8.20
5	4.10	6.80	4.60	4	4.5	6	6.1	6	8.2	9.00
Time	Mid-day Peak Period									
1	7.20	5.30	6.10	5.6	9	5	7.2	5	8.4	8.1
2	4.60	8.60	4.00	6.6	5	4	8.6	8	3.6	5.3
3	9.10	5.70	4.60	3.4	7	3	6.5	6	6.6	6
4	8.20	5.30	3.90	6.2	3	5.5	7.7	2	2..7	7.1
5	4.00	7.30	5.80	4	6	6	7	4	7	6.2
Time	Evening Peak Period									

1	6	2	4	2	6	3.2	6.3	7	1	7
2	5	6.1	6.1	5.3	5	9	4.3	5	2	1
3	8	6.5	0.9	4.6	6.5	2	7.4	5	4	6
4	3.3	2.4	5	7	4	7	4	3	7	5
5	4.4	5.8	5.9	5.4	1.2	3.2	2	1	2	7

Table 7: ***headway (second)*** ***for Awutobis tera and New ambo Approaches***

3.5.1.4 Field Measurements

The field measurements have been conducted on the numerical feature of the intersections selected. Intersection layout is primarily composed of the alignment of the legs, width of traffic lanes, bicycle lanes, crosswalks, sidewalks on each approach, number of lanes, median, street-side elements and the method of treating and channelization of turning movements. Like the design of the thoroughfare's cross-section, the design of an intersection's layout requires a balance between the needs of pedestrians, bicyclists, vehicles, freight and transit in the available right of way. Beyond intersection layout, the practitioner needs to work with a multidisciplinary team to address accessibility, traffic control and placement of equipment, traffic operations, lighting (safety and pedestrian-scaled), landscaping and urban design.

During field measurement, alignment of the legs, the width of traffic lanes, crosswalks, number of lanes, median and the method of treating and channelization of turning movements has been measured on each approach for the selected intersection.

The width of the traffic lane and median measurement is done manually using a tape meter; the same method is used for the roundabout. The rest of the data were collected by visual observation. The collected data are summarized in the following tables and figures for the four selected intersections.

Field data for intersections

Asera 18 Mazoria junction						
Approach	**No-of lane**	**Lane width**	**Median width**	**Cross ways**	**Pedestrians**	**Street furniture**

Awutobis tera	3	3	4	No	no	No
Ashewa meda	3	3	4	Yes	Yes	No
Winget	4	3.5	10	Yes	Yes	No
Torayiloch	4	3.5	10	Yes	Yes	no

Table 8Asera 18 Mazoria junction field data for intersections

3.6 Secondary Data

Traffic accident data has been collected from the Kolfe Keranio Sub City traffic police administration. The office provided five years of accident data. The accident data for this intersection is shown below in Table 13

Traffic Accident vs. Accident Severity				
Accident Severity	Year			
	2016/2017	2017/2018	2018/2019	2019/2020
Fatal	45	50	65	85
High	35	32	28	30
Low	106	95	71	150
Property Damage	173	135	166	200

***Table 9*Total Traffic Accident at intersections in years**

Poor road network; absence of knowledge on road **traffic** safety; mixed **traffic** flow system; poor legislation and failure of enforcement; poor conditions of vehicles; poor emergency medical services; and absence of **traffic accident** compulsory insurance law have been identified as key determinants of the problem from the study area. The latest Total Traffic Accident reported at intersections in four years, the reports increased from year to years, these traffic accidents causes for traffic jams at the study area. As I mentioned in the above table the rate of traffic a accident in 2019 increase by 50 percent when compared to 2017 years reports data.

Month	Number of an accident at Asera Simint Mazoria Intersections
July,2019	15
Aug,2019	11
Sept ,2019	16
Oct ,2019	18
Jun ,2018	17
Feb ,2018	13
March ,2018	19
April ,2017	13
May ,2017	17

Table 10 **Total Traffic Accident at intersections in months**

Every single day minimum of 12 persons died due to road traffic accidents, in Ethiopia 4597 peoples were died in 2019 and a huge amount of property damage was happened (*federal road transport authority*) on 14th international road traffic accident victims.

According to the study area the number of road traffic accidents increased from time to time. As I mentioned in table 14 the data were goes up and down based up on the seasons.

CHAPTER FOUR

4. Result and Discussion

Analysis was done on the selected intersection using the collected data following the proper and best method and the results are presented in the following sections with a brief explanation.

4.1 Respondent characteristics

As discussed in section 3.5.1.2 questioner was distributed randomly to evaluate the perception of different road users to wards traffic congestion in the city. Out of the distributed 68 questioners 100% of it was returned. Table 15 shows the questioner respondent profile and Figure 6 shows the respondent perception related to the existence and level of traffic congestion at intersections.

		Number	Percentage
Questioner	Distributed	50	100%
	Returned	50	100%
Sex	Male	35	70%
	Female	15	30%
	Total	50	100%
Age distribution	20-25	20	40%
	25-30	15	30%
	30-35	10	20%
	35 above	5	10%
	Total	50	100%
Group of distribution	Passenger (taxi)	15	30%
	Passenger (public)	20	40%
	Drivers(private)	5	10%
	Drivers(Taxi)	8	16%
	Traffic Polices	2	4%
	Total	100	100%

Table 11 shows questioner respondent profile

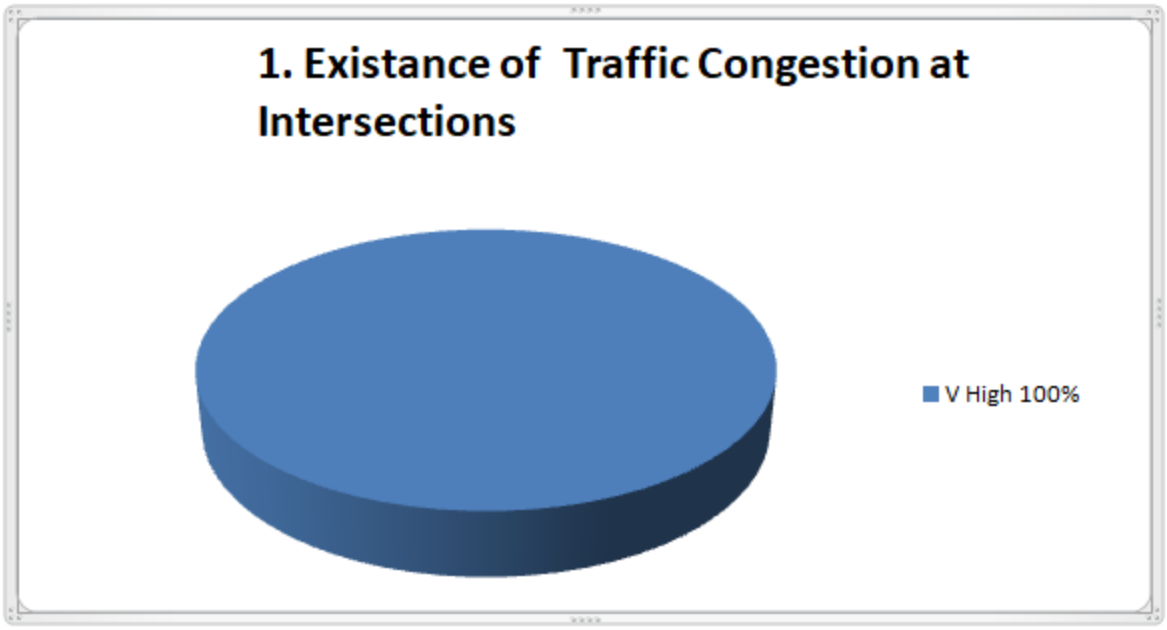


Figure 5 shows the respondent perception related to the existence

Respondent's Perceptions existence of traffic congestion at intersections

I. Existence of Traffic Congestion.

According to the result of respondent's Perceptions about the existence of traffic congestion. Asera simint Mazoria, is the most congested one in the sub-city. The intersection has 4 approaches namely, Wingate Approach, Torayiloch Approach, Awutobis Tera Approach,and new ambo Approach, each approach are fully more congested.

Existence of Traffic Congestion.

According to the result of respondent's Perceptions about the existence of traffic congestion. Asera simint Mazoria, is the most congested one in the sub-city. The intersection has 4 approaches namely, Wingate Approach, Torayiloch Approach, Awutobis Tera Approach,and new ambo Approach, each approach are fully more congested.

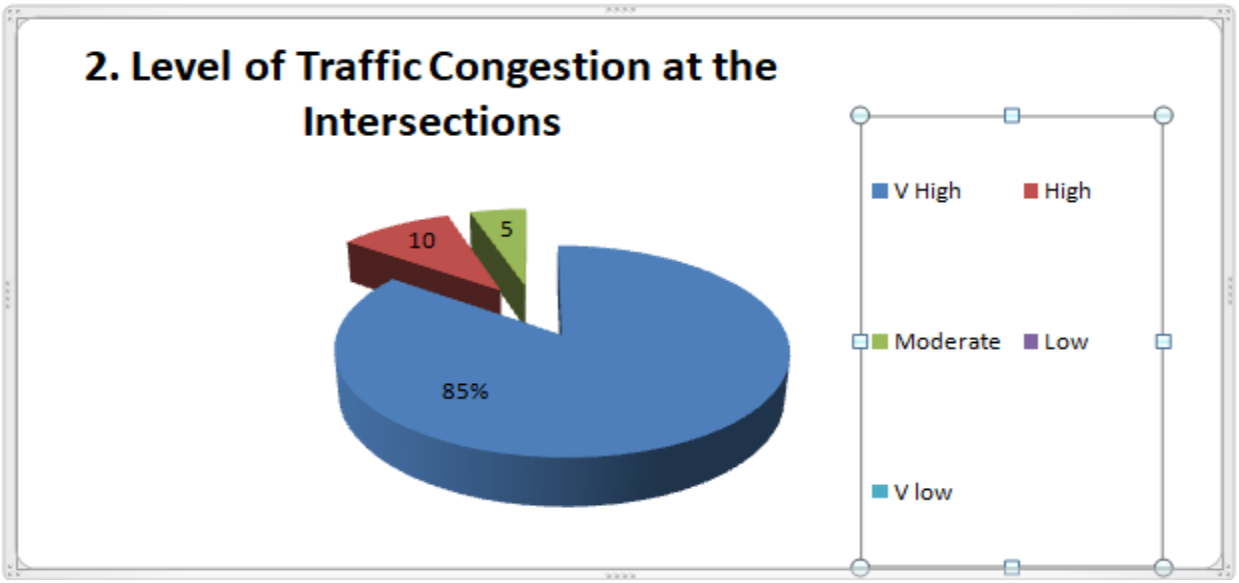


Figure 6 level of traffic congestion at intersections.

Respondent's Perceptions on level of traffic congestion at the intersection

II. Level of Traffic Congestion at the Intersection

On the other hand the result of respondent's Perceptions about the Level of Traffic Congestion at the Intersection is very high in the sub-city. Each intersections has high level of traffic congestions

4.2. Traffic Volume Analysis

A directional traffic volume analysis was conducted on traffic volume data, which is counted at 15-minute intervals. The traffic count was done for a specific hour of a day starting from the early morning to the late afternoon and evening. Therefore, traffic volume analysis is done for all approaches of the one intersection.

4.2.1 Passenger Car Unit Analysis

Different vehicle types occupy different spaces on the road, move at different speeds, and start at different accelerations. Furthermore, the behavior of drivers of the different types of vehicles may also vary considerably. This poses a problem for designing as well as planning roads, intersections, and traffic signals. A uniform measure of vehicles is thus necessary to estimate traffic volume and capacity of roads under mixed traffic flow. This is rather difficult to achieve unless the different vehicle types are stated in terms of a common standard vehicle unit. For these reasons, the concept of Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) was developed and it became a common practice to convert the other vehicle types into PCUs. It is

generally expressed as PCU per hour, PCU per lane per hour, or PCU per kilometer length of the lane. (Rana and Mohit, 201

Traffic volume at 18 Mazoria junctions

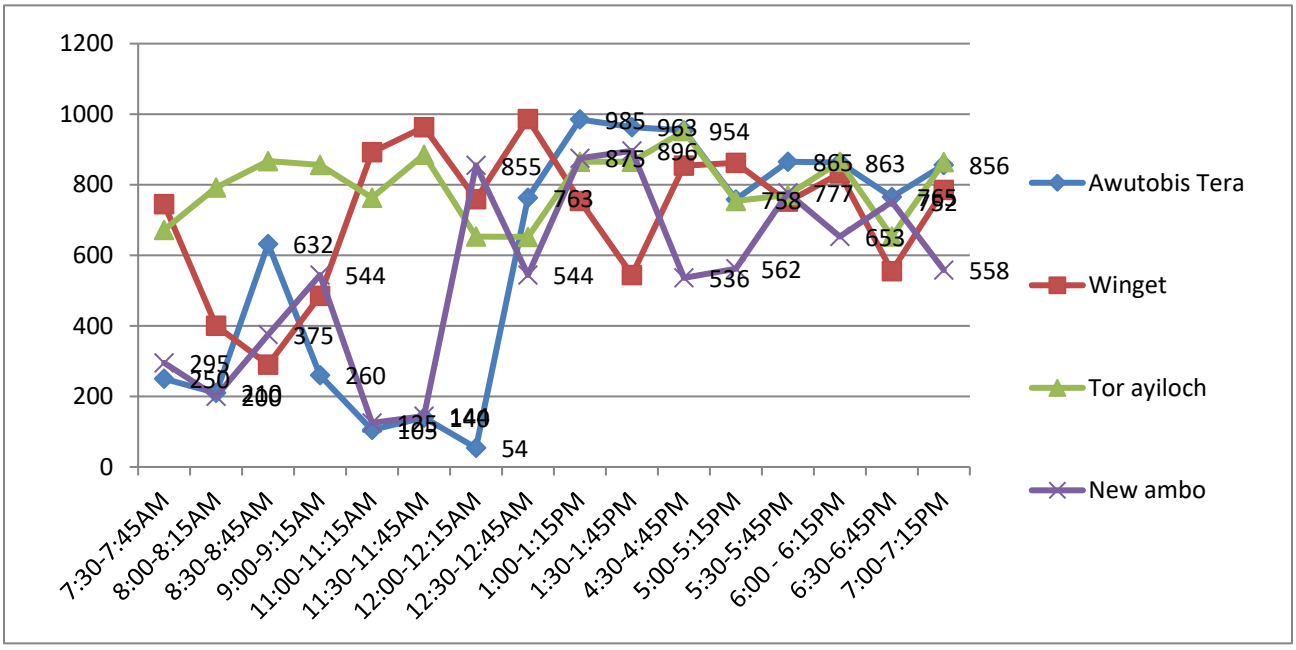


Figure 7 Total Traffic Volumes Count Data for 18 Mazoria junctions

Total Vehicle Compositions at Asira Simint Mazoria

As we see from the above Figure 19, there are different types of vehicle compositions at 18 Mazoria intersections. Both types of vehicular compositions are the largest percentage Composition of vehicles in this intersection. except4WD.

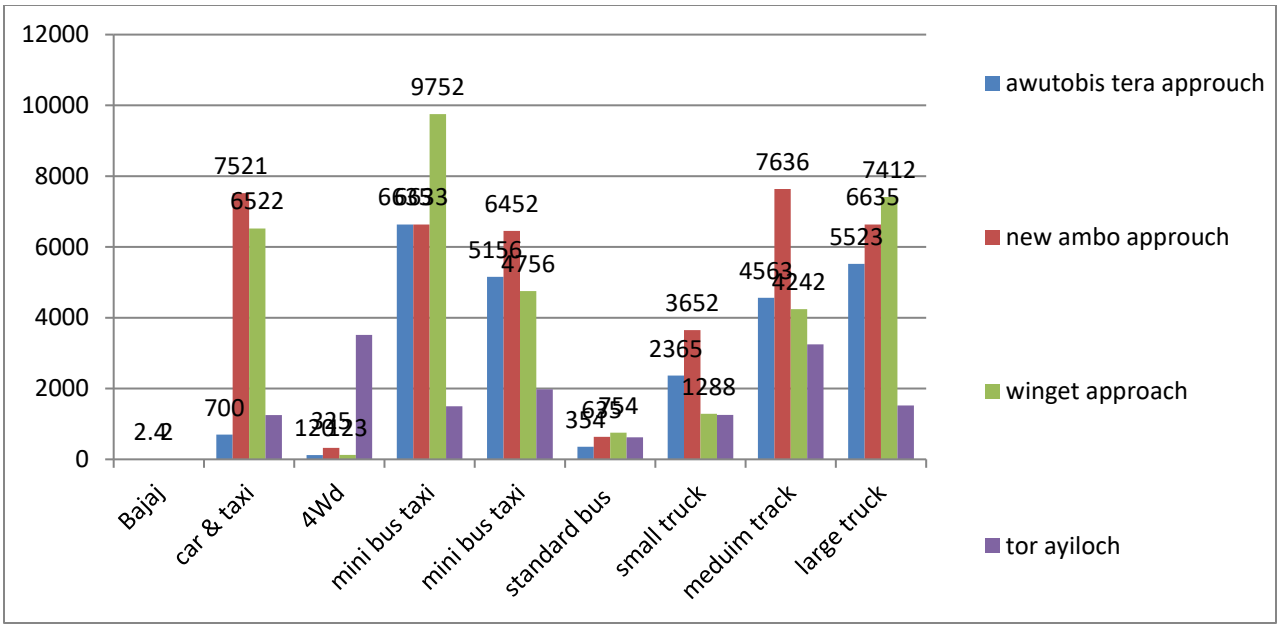


Figure 8 ***Total Vehicle Compositions at Asira Simint Mazoria***

The Figure 19 shows the total vehicle composition at Asira Simint Mazoria. Among different kinds of vehicle composition, car and taxi have the highest number of composition in all four approaches. Mini bus taxi, medium trucks and min/medium buses are also the next higher composition value in this intersection.

4.4 Congestion Analysis

From different types of congestion analysis approach, the researcher chooses the Travel time approach with the best advantages which was mentioned in Chapter Three. The following congestion measures were analyzed, and these are; Average travel time, Average speed, Travel rate, Delay rate, Delay ratio, Total segment delay. Accordingly, the discussions of each parameter are shown in the subsequent sections.

4.4.1 Travel time

As we can see below in Figure, there is Average travel time at 15 min. interval for the segment selection. The result shows that during morning and evening time the highest travel time and the lowest travel time were recorded during midday off-peak time. When compared each other the Awutobis tera approach has the highest peak travel time during the morning and evening time. And also the new ambo approach has the next highest travel time. Morning and evening time.

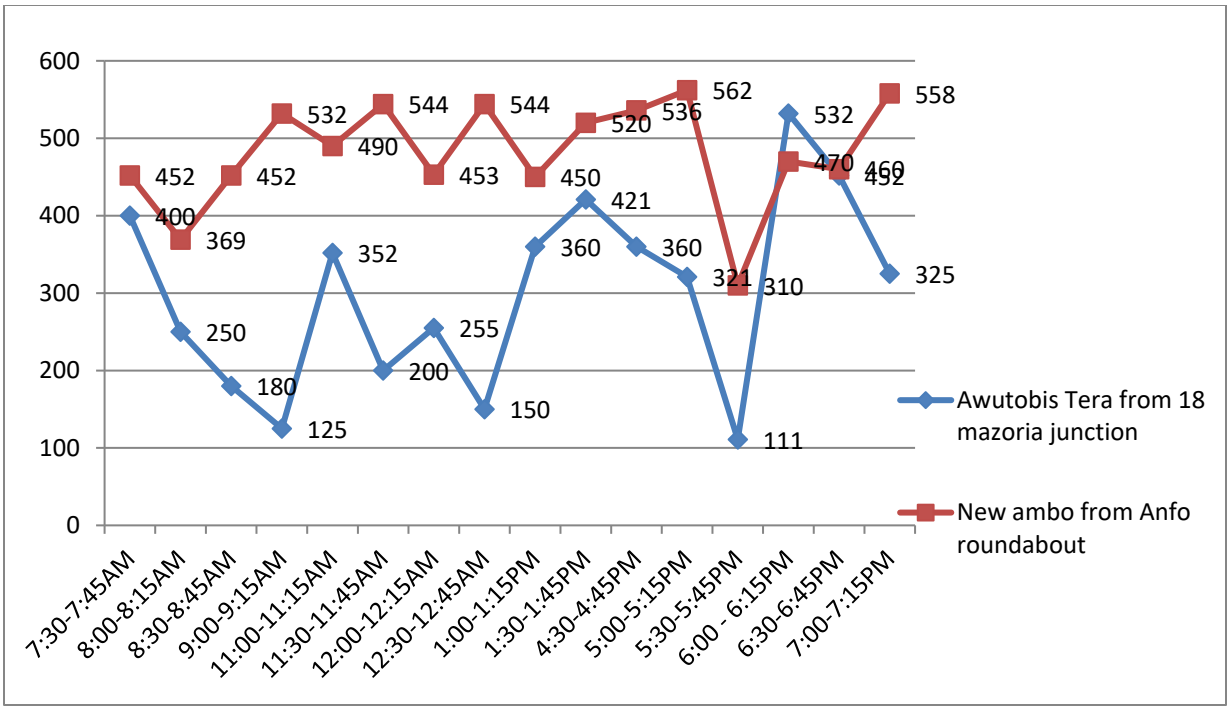


Figure 9 Travel Time for Selected Approaches (Sec).

4.4.2 Average Speed and Travel rate

The average speed calculated at the congested road sections considered in this study is shown below. The result shows that during the morning period travel speeds at the sections are almost below 5 km/hr. and below 10 km/hr. up to midday. However, during midday the travel speed increased to the maximum value. During the midday, the Awutobis Tera approach shows the highest travel speed of 20 km/hr.

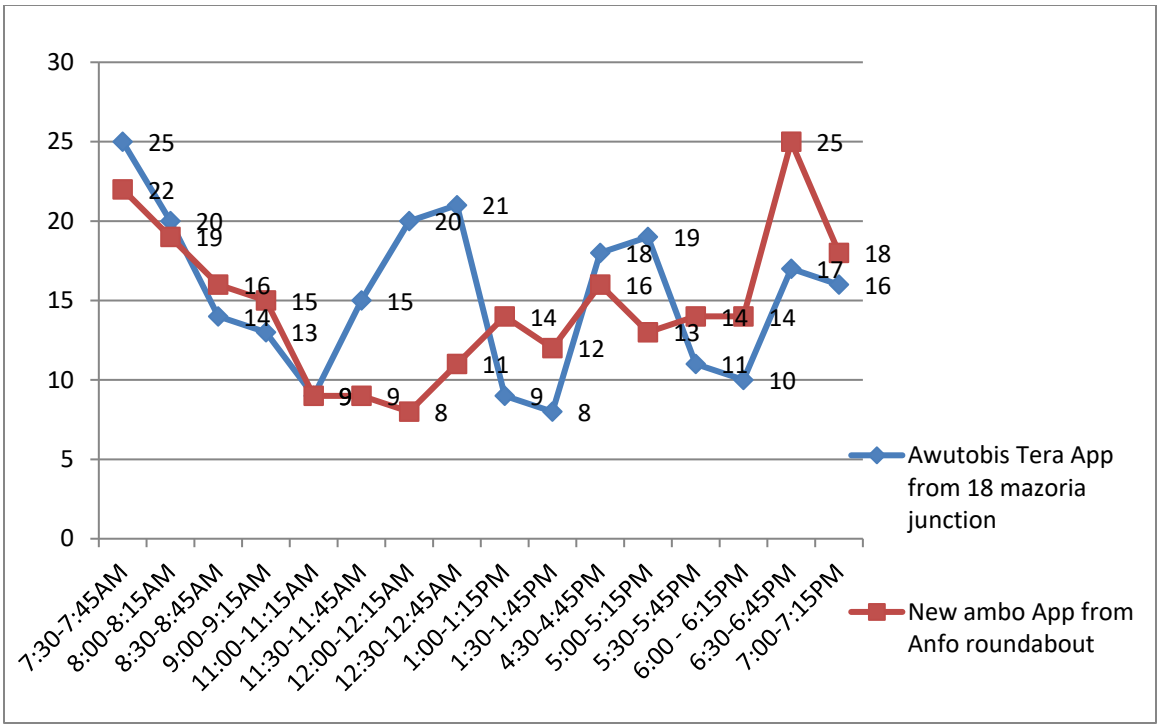


Figure 10Average Travel Speed for Selected Approaches (km/hr.)

The travel rate which is the inverse of travel speed and the very important parameter in congestion analysis is calculated and presented below in Figure 22. The figure shows that the travel rate during the morning and evening peak period is higher than the midday off- peak period.

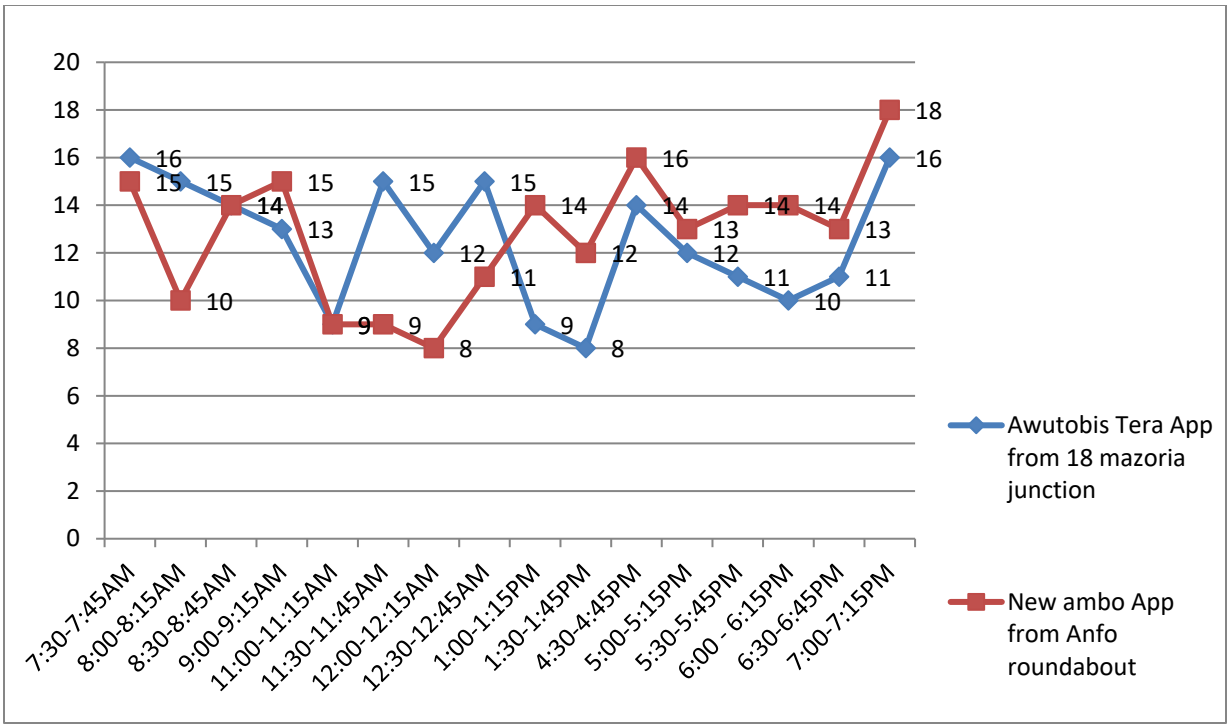


Figure 11 Travel Rate for Selected Approaches (min/km).

4.4.3 Delay rate, Delay ratio, Delay

Delay is one of the important parameters in congestion measure analysis. For the analysis of delay rate, delay ratio and delay the posted approaching speed at the intersection is used as a reference. Delay is the amount of extra time spent in congestion compared to the time it would take under ideal or free-flow conditions.

Delay rate is the rate of time loss for vehicles operating in congested conditions, expressed in minute per kilometer for a specified roadway segment. It is calculated as the difference between the actual travel rate and the acceptable travel rate. The quantity can be used to estimate the difference between system performance and the expectation for those system elements, which can be used to prioritize alternative improvement.

Delay ratio is a dimensionless measure that can be used to compare or combine the relative congestion level of facilities with different operating characteristics like freeways, arterial streets and transit routes. It is calculated as the delay rate divided by the actual travel rate. The delay ratio identifies the magnitude of the mobility problem in relation to the actual condition.

Therefore, the result of Delay rate, Delay ratio and Delay are listed in Figure 23 and 24.

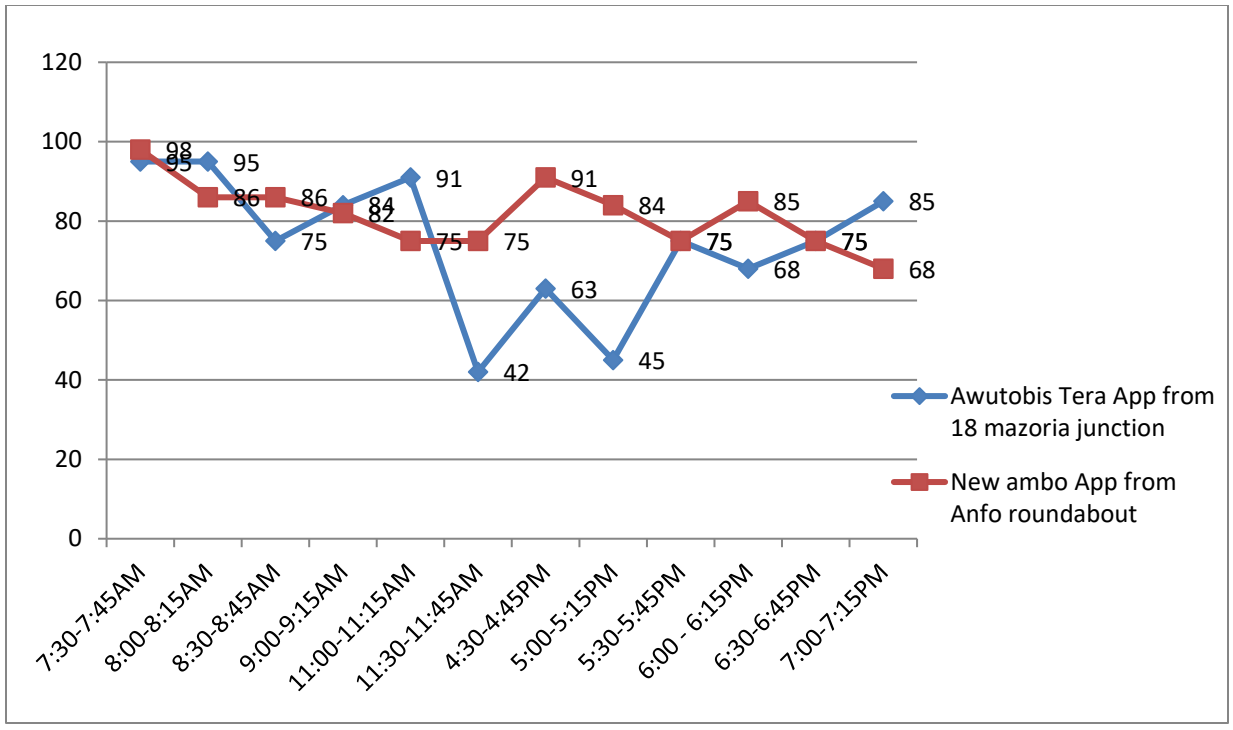


Figure 12Delay for two Intersections (sec).

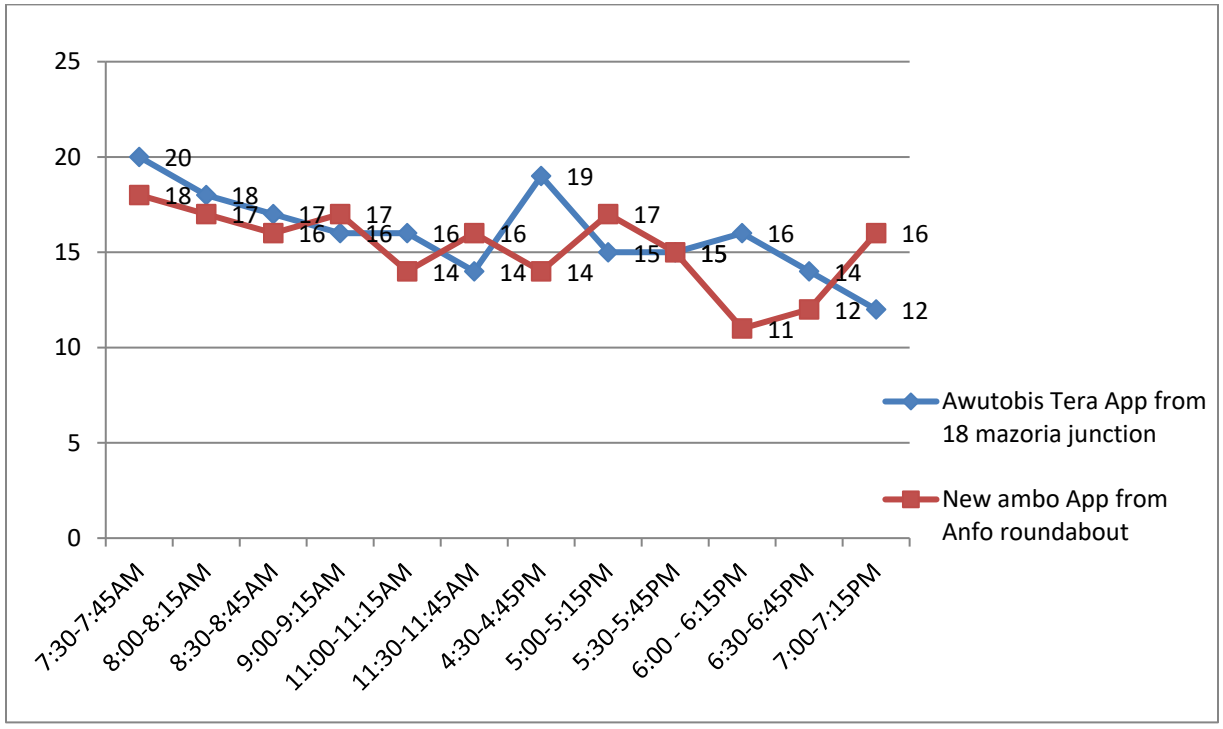


Figure 13 Figure: Delay Rate for two Intersections (min/Km).

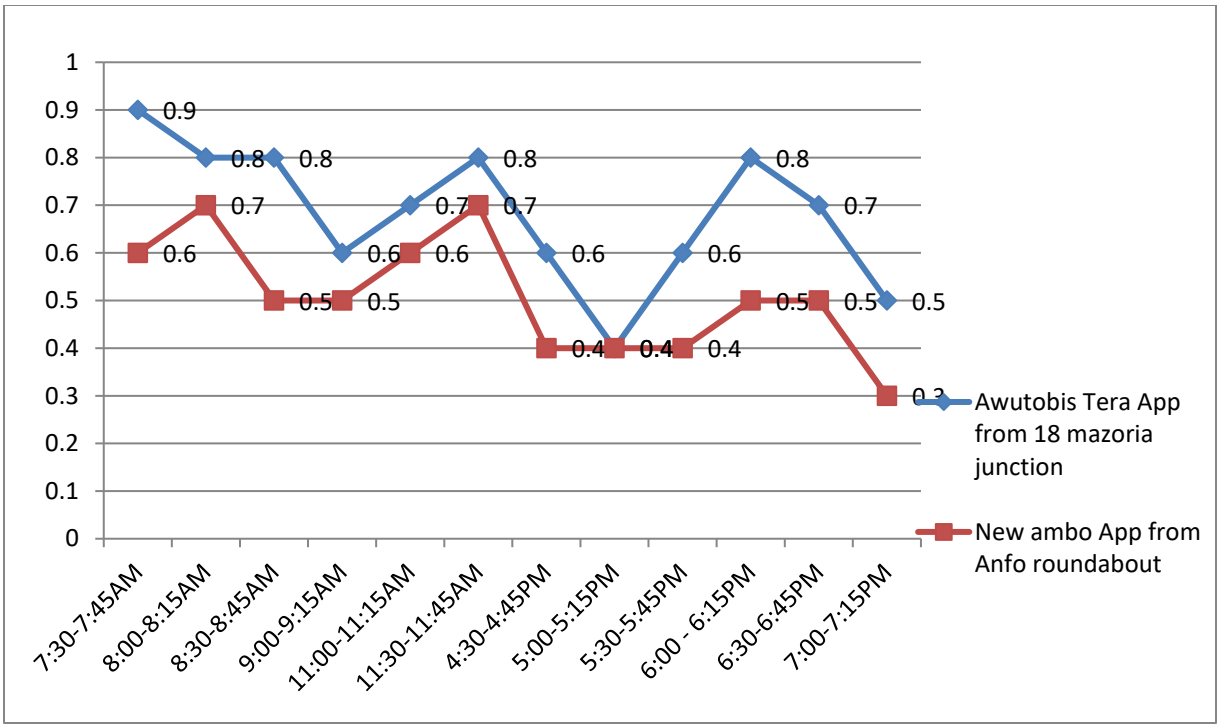


***Figure 14* Delay Ratio for two Intersections**

The delay analysis express, from 18 Mazoria Intersection, the Awutobis Tera approach has the highest delay at both morning and evening peak time with 87.1 second and 85.5 second respectively. The Figure 25 shows the delay ratio which is the ratio of delay rate to actual travel rate for all the legs studied. Accordingly, though the delay rate amount is different for the morning and the evening peaks; and the delay ratio is also different from time to time. The delay ratio for two intersections of two selected approaches are from 0.4 to 0.9 was observed.

4.5 Causes of Congestion

Traffic congestion is one of the major problems facing Addis Ababa City and it is attributed to a number of factors including rapid population increase, inadequate and poor road infrastructure, city structure, rapid increase in the number of cars and lack of a physical plan to control city development.

According to the results, based on the traffic volume count study analysis the cause of 18 Mazoria intersection is due to the higher number of road users during the morning and evening peak hours and as the area are entrance and exit of Addis Ababa city there is the existence of large trucks.

And the cause of Anfo roundabout is due to lower signal timing, absence of posted seconds count down and behavior of drivers which is being eager to pass the intersection will aggravate the increase of traffic congestions.

Therefore, the common feature of traffic congestion in developing countries shows that the root causes emanate from lack of proper planning, improper use of limited road network and bottleneck problem.

4.5.1 Traffic Congestion and Traffic Accidents

According to the data which was collected from the Kolfe Keranio sub-city Traffic Police commission, Figure shows that the distribution of traffic accidents in the sub-city from 2007 E.C to 2010E.C.

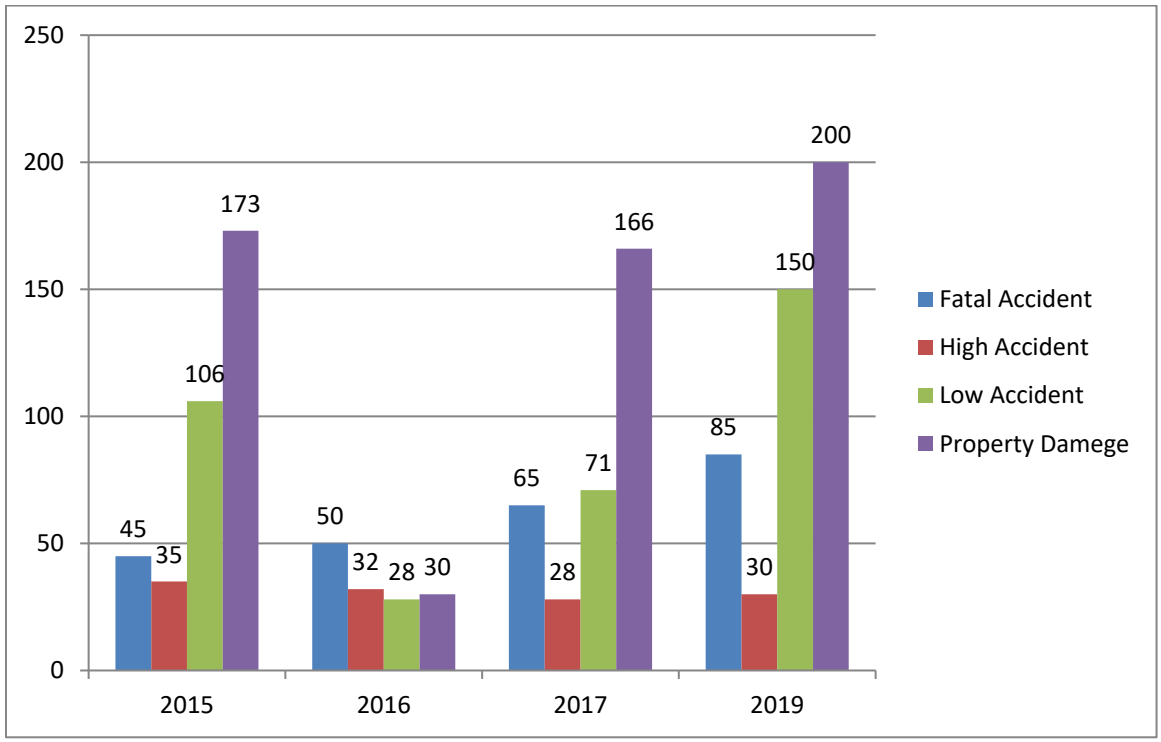


Figure 15 Traffic Congestion and Traffic Accidents at

As shown below in Figure the type of traffic accidents that occurred at two selected intersections is mostly vehicles to vehicles accident. Which is due to the occurrence of traffic congestion at selected intersection and the behavior of drivers are being eager to pass those intersections finally, traffic accident will happen. From the two intersections, the 18 Mazoria intersection has a larger number of traffic accidents than Anforoundabout intersection.

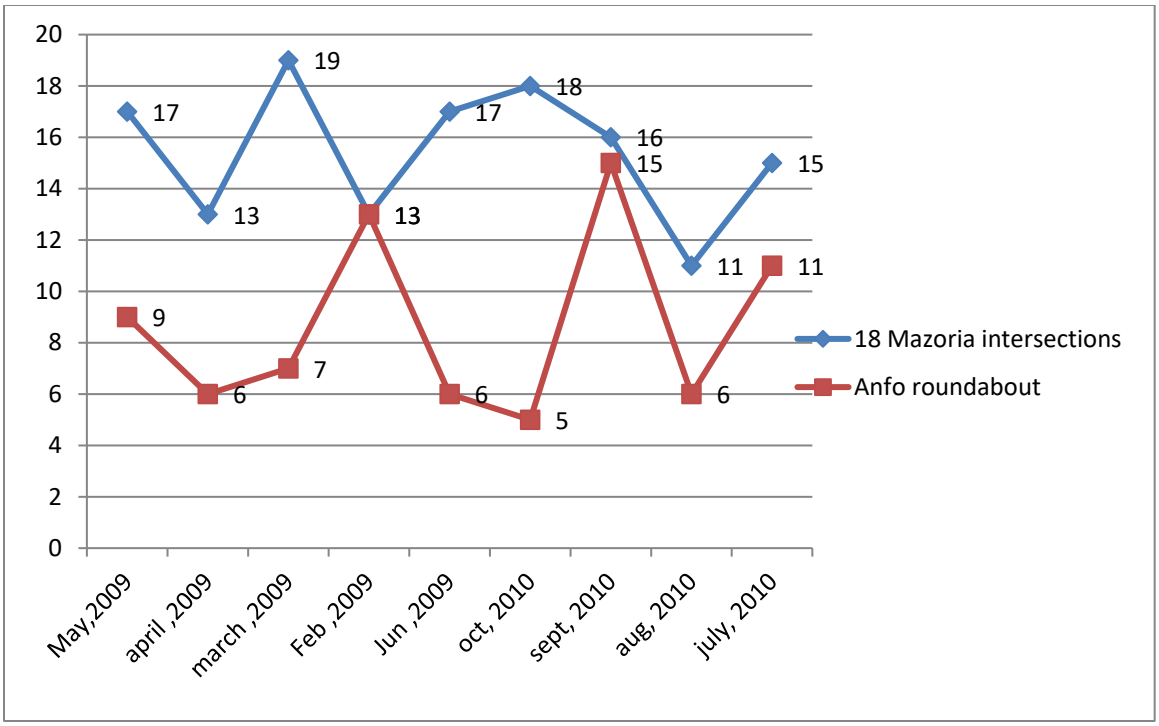


Figure 16 the 18 Mazoria intersections has a larger number of traffic accidents than Anforoundabout intersection

CHAPTER - FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study discussed urban street segment assessment of socio-economic impact of urban road transport congestion. Traffic congestion is one of the significantly recognized urban transport problems. It is continues to remain a major problem in most cities around the world, especially in developing regions resulting in massive delays, time losses and financial losses. The issue of traffic congestion in Kolfe Keranio sub-city is becoming a serious challenge to effective flow of people and goods in the city. The study focused and assessed the socio-economic impact of urban road traffic congestion on passengers' time losses and etc. Based on this research finding the following conclusion was made.

Based on this finding of the analysis in this study, the following points are concluded.

- Generally, Transport in study area is disordered, inefficient, unreliable and dangerous. Traffic congestion during the morning and night peak hour is more than that of the mid-day and wasted fuel and losses of time is high relative to the mid-day. Due to road traffic congestion loss of productivity, inhibiting human development and reducing the quality of life, change in accident frequency and characteristics, increased vehicle operating costs and increased noise nuisance, increase wastage of time, increase delay, increase wastage of fuel, lack of comfort.
- According to the Total traffic volume distribution, the two intersections have the morning and evening peak period with congested nature.
- It has led to an increase in accidents, which cause death, destruction of properties, permanent disability and injuries. The trip makers answered more than 90 percent of respondents agreed for this impact.
- The *Level of Service* data has shown that the intersections are performing above their capacity, specifically, 18 Mazoria with the LOS F almost for all approaches.
- Based on the observation, the main cause for the happening of traffic congestion at those selected area is due to the performance of **over capacity**. The LOS analysis shows almost all approaches at the intersections are serving above their capacities.

- The two intersections at selected approach, the average and total segment delays have the morning and evening peak periods. The delay ratio for two intersections of two selected approaches of Awutobis Tera and new Ambo Approach are from 0.58 to 0.83 as observed respectively.
- As a mitigation measure, increase the capacity of the highway has a better result than decrees the traffic volume.
- Based on observation, most of causes of congestion are due to improper traffic. However LOS analysis shows almost all approach on the intersections are serving above their capacity resulting increase in travel time and transportation cost.
- As we see from the Total cost of congestion analysis, during peak times total travel time are increased.
- It was observed that, traffic accidents are mostly observed at the over–congested areas of 18 junctions. Therefore, we can conclude that traffic congestion will increase traffic accidents.

5.2.0 Design Recommendations

5.2.1 Urban Design Principles.

The amount of congestion costs seems to be systematically overestimated, especially when compared to other external effects, like environmental cost, Accident costs. Essential for any successful strategy to maximize the social benefits of transport and to minimize the costs of traffic congestion is a combination of efficient transport economy measures, sustainable road design, and intelligent traffic control.

In addressing the problem of traffic congestion, the respondents and various stakeholders gave a number of suggestions and recommendations to the respective authority.

- **Improving public transport**

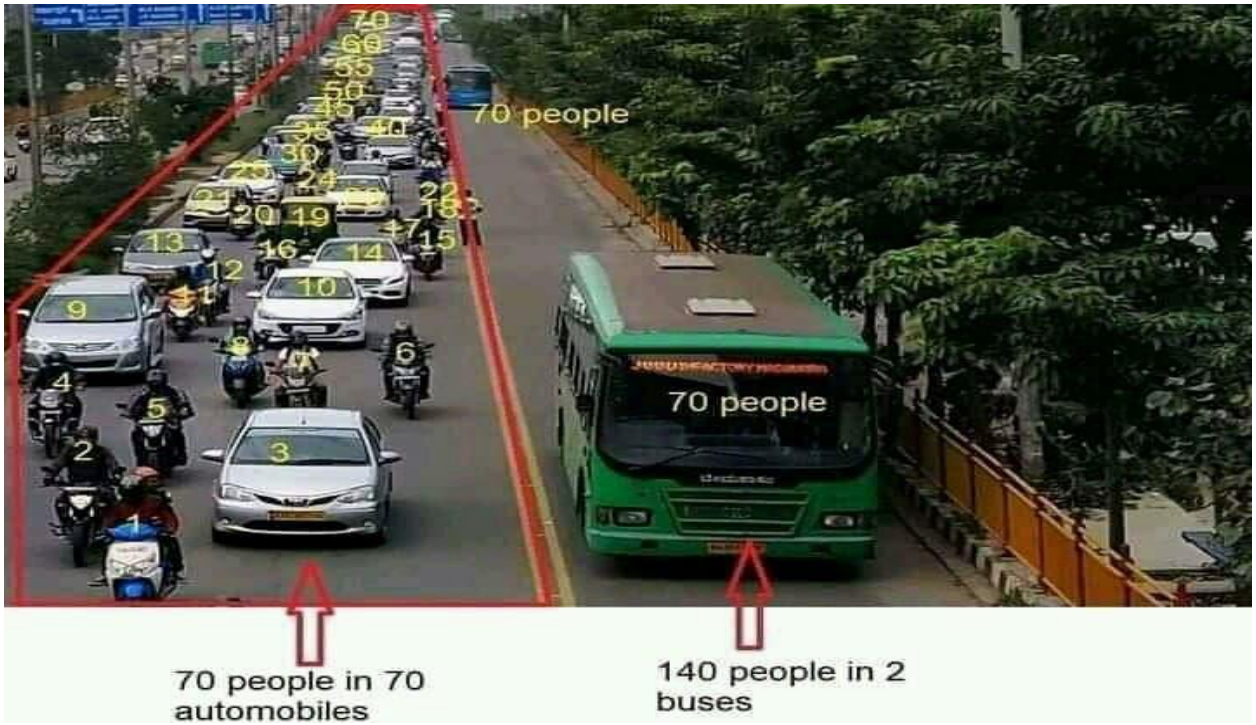
Public transport has the potential to transport more people than individual cars for given amount of road space. The promotion of public transport remains a fundamentally important congestion management strategy. When public transport provides quality service, it can maintain a high level of access throughout urban areas with a drop in overall car usage. Since government must be increasing the amount of public transport and enterprise bus service.

- **Road Safety**

Safety on roads for pedestrian as well as for drivers is an important aspect of life. Before to build the road must be considering the first is safety for pedestrians and drivers especially disable persons. Without considering the road safety traffic injuries represent a leading and increasing contributor to regional to and global disease burden. However the government must be before construct the road to analyze and consider safety becomes first.

Discourage private cars

A bus can be accommodate people as much as provided by many cars and occupy less space on roads. It will be terribly useful to cut back a load on the road by discouraging non-public car. It is possible to discourage people from the private car is very easy in low-income area and ultimately reduce traffic load and congestion. It is clearly that road space occupancy of bus is much lower as compared to cars and also the pollution caused by cars is more as compared to bus.



Avoiding poor Traffic management

The poor traffic management is a result of malfunctioning of traffic light, absence of road signals, inadequate enforcement of laws (e.g. illegal trade, construction works, etc.), low penalties given to punish violators of traffic congestions, employment of few law enforcers for instance traffic police and lack of facilities to tow disable vehicles on the road.

Traffic management refers to the direction, control and supervision of all vehicular and pedestrian traffic around congested road. Good traffic management is key to achieving the goal of road traffic management for safe and efficient road network for urban congested road. This involves management and control of road signals, road spaces, parking spaces and road users. So that, the city of Addis Ababa traffic management as much as possible to responsible manage the road traffic congestion. The policy makers shall deduce relevant measures to minimize the costs

of traffic congestion especially by implementing appropriate transportation system management that is optimizing system capacity operation.

Effect of on-street parking

Effect of on street parking on road way capacity of the road is decreasing. Especially the width of the road is very narrow; it becomes the results of congestion and affects the travel time of people or employment. On-street parking must be a design consideration to ensure user convenience, and economic well-being of abutting properties. The government is must be parking lane width safe for vehicles and not effect on moving vehicles through the lane.

 Pedestrian crossing

Pedestrian crossing is the one of the impact of congestion well happened. Because the pedestrian moving on the crossing the driver stop some instant of time. During this time the queue formed and travel time lost. Most of peoples moving and crossing road is illegally means they have not used zebra crossing which is used arbitrary ways. The pedestrian crossing is design to be consideration of number of peoples where crossing, school zone, market, residential settlement, recreational area, governmental administrations etc. So that the government or traffic police to educate the people about road crossing law and give penalties when the unlawful persons.

 Separate route for heavy loaded traffic

Route must be separated according to different classes of vehicles, heavily loaded trucks should not be allowed into the main passenger and market area and separate route must be specified for these during peak hours.

Further Researchers

 Further research should be conducted to extend all aspects of this research, such as by collecting more data the whole city in order to improve results.

 During collecting travel speed and travel time modernized data collection method are better than manually method and to minimize the error and the work to simplify.

 In order to analysis total economic cost of congestion as much as possible including environment cost, fuel cost, and accident cost.

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