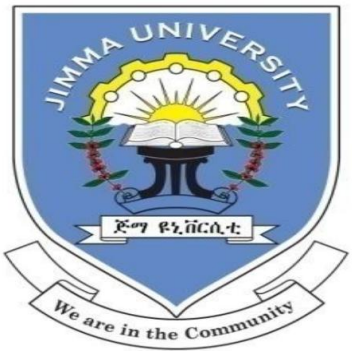

Jimma University

School of Graduate Studies

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Highway Engineering Stream

ASSESSMENT ON PASSENGERS' CHOICE OF TRANSPORTATION MODES IN ADDIS ABABA: A CASE STUDY AT " TOREHAYLOCHE - MEXICO" ROUTE

By:

Dawud Esmael

A thesis Submitted to School of Graduate Studies of Jimma University in Partial Fulfillment of the Requirements For Degree of Masters of Science in Civil Engineering (Highway Engineering Stream)

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October, 2017

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DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all source of materials used for this thesis have been dully acknowledged.

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Title of the thesis:

Assessment on Passengers' Choice of Transportation Modes In Addis Ababa: A Case Study at " Torehayloche - Mexico" Route

I have submitted this thesis for examination with my approval as university Adviser for the above mentioned title**.**

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Date: _____

Co-advisor

Name: Eng. Murad Mohammed

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Date: _____

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ABSTRACT

In satisfying the need to move, public transport has a recent time becomes the most commonly used mode of transport. Passengers are perceived to act as rational beings, choosing travel modes most likely to offer them maximum utility. The choice of a suitable transport mods greatly affects the affectivity as well as profitability of the realized transportations. Therefore, the ways public transport services are delivered as well as their quality is important because of their effect both on the passengers and the demand of service.

This paper attempts to assess passengers' choice of transportation modes along the route of Torhayloche - Mexico, to examine citizens' perceptions of the Bus, Taxi, and Light rail conditions. A multinomial logit model is developed in order to account both socio-economic and transport related parameters. The study basically relies on primary data for its analysis and findings; however primary data has been generated and analyzed with the help of questionnaires and sample surveys. Using questionnaires, the study was conducted at five main terminals along the study area involving 359 passengers who were available to be at the various terminals during the survey.

The overall findings of this study revealed that passengers among others socio-economic factors; sex and income have values of (p=0.032) and (p=0.001) respectively and transport related factors as (p=0.000) have significant influences on public transport mode choice. The result indicates, majority of the passengers were using LRT (43.45%) and (28.97%) Minibus taxi and the remaining (27.58%) of the passengers choice were Anbessa City bus.

The research concludes that the choice of travel mode is affected by everything from transport-specific factors to socio-economic parameters. Since, majority of the passengers are choose the Light rail transit therefore there should be an enhancement of Light rail transit and considering also the quality as well as quantity of those Anbessa city bus, Minibus taxi is important. Finally, the paper puts suggestions that revolve around policy issues and decision making considerations.

Key Words: Mode choice, Mode choice factors, Transportation, Transport system

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ACRONYMS

AU	African union
CSA	Central Statistics Agency
BRT	Bus Rapid Transit
ECA	Economic Commission for Africa
ERA	Ethiopian Road Authority
ETB	Ethiopian Birr
GDP	Gross Domestic Product
LRT	Light Rail Transit
ORAAMP	Office for The Revision of Addis Ababa Master Plan
PTC	Public Transport Corporation
SPSS	Statistical Package for Social Science
TPB	Theory of Planned Behavior
UNECA	United Nation Economic Commission for Africa
US$	United States' Dollar

CHAPTER ONE

INTRODUCTION

1.1 Background

It is an undeniable fact that mobility is part of the daily round of activities and as such an essential component of the life of every human being (Albalate, et al., 2010). Transport plays a vital role in the development of the modern era as an integral part of the socio-economic and political structure of the country. Thus urban transport, transport infrastructure, modes of transportation, and traffic management should involve optimal integration of the means and ways of mobility to create maximum ease and comfort maintaining the socio-economic and physical integration of the city (Kottenhoff, 1999).

Public transport services are mostly delivered either by private or public organizations regardless of the party that delivers them, public transport services require substantial investment and high operating costs. Factors such as service productivity and efficiency are essential in this respect as they influence public transport demand and patronage (Barnum, et al., 2007).

Trip makers /passengers are perceived to act as rational beings, choosing travel modes most likely to offer them maximum utility. There is little doubt that wide range of factors influences the choice of one public transport service provider to the other. polat (2012), has identified the following as public transport demand determinants: fare, travel time (walk access time and reliability, availability and costs of alternative travel modes, time of travel, purpose of travel and lastly the level of public transport dependency). Existing literature also tends to suggest that choice of mode for various trips is either directly or indirectly influenced by socio-economic factors including their age, gender, household size, educational attainment and income (Domencich, 1975).

Transport is an essential element of city development that, in turn, is a major source of national economic growth. Simply stated, poor transport inhibits growth. It has also shown in this report socially, transport is the means of accessibility to jobs, health, education and social services (World bank, 2001).

Public transportation in Addis Ababa are the blue-white line "Taxies" which are shared Minibus, Anbessa bus, Sheger bus, Public bus, Higer bus, Star alliance bus and the newly introduced Light rail and it is a crucial part of the solution to the nation's economic, energy, and environmental challenges helping to bring a better quality of life. In increasing numbers, people are using public transportation and local communities are expanding public transit services. Individual, families, communities, and businesses-all are benefits from public transportation (Addis Ababa City Transport Authority, 2005).

1.2 Statement of The Problem

Transportation is the key infrastructure of the country; because a country's economy is depend on how well served the country by its roads, railways, airports and shipping. The country's economic growth is very closely linked with the transport sector growth (Darido, 1975).

Transport theory (or the law) stresses strongly that whatever the mode will be, it should primarily consider the human aspect (i.e. safety, livability, economy, satisfaction etc.). This gives every individual the right to choose the services that he/she desires (Kottenhoff, 1999).

The nature of public transport service shapes their own demand characteristics and vice versa. These characteristics are essential to be known in prior for better understand of the factor that affects the demand (Albalate, et al., 2010).

The choice of travel mode is affected by great many factors, everything from transport-specific factors (describing the various components of the transport system such as: comfort, travel time, fare) to socio-economic parameters such as: age, gender, household size, occupation, educational attainment and income (Domencich, 1975).

Public transportation is an important element in day-to-day activities in Addis Ababa because: it is relatively affordable means of transportation. Infrastructure is not sufficient to promote private vehicle ownership, and also it promotes redaction of environmental pollutions (Addis Ababa City Transport Authority, 2005).

Even though the role of public transportation is very high, the service provision is not good enough as the demand is much greater than the supply. As the population and the number of passengers increase, service should be expected to grow and become advanced. This is not practically true in Addis Ababa because of financial and managerial constraints. Despite the prevailing problems, efforts to make an empirical study of the transport service in the city are still not sufficient (Addis Ababa City Transport Authority, 2005).

This study, therefore, intends to fill the identified gaps, by reviewing how and why the travelers choose their mode of transportation by correlating the transportation mode choice with socio-economic and transport related factors to gain information and knowledge about transportation system in the city. Thus, it provides solutions and suggests a remedial measure that should be taken to make it play a leading role to maximize urban mobility.

1.3 Research Questions

1. What socio-economic factors influence the choice of public transport modes and to what extent?
2. What transport related factors influence the choice of public transport modes and to what extent?
3. Which socio-economic and transport related factors have a significant association with public transport mode choice?
4. What is the appropriate mode choice model that accounts both socio-economic and transport related factors?

1.4.Objectives of The Study

1.4.1 General Objective

The general objective of the study is to assess passengers' choice of modes of transportation in Addis Ababa, particularly along "Torhayloche - Mexico" route.

1.4.2 Specific Objectives

- To identify and compare socio-economic factors which greatly affect public transportation mode choice.
- To identify and compare transport related factors which greatly affect public transportation mode choice.
- To find out the level of association of socio-economic and transport related factors with the transportation mode choice.
- To develop a mode choice model and to assess passengers mode choice accounting both socio-economic and transport related factors.

1.5 Significance of The Study

This research document is significant in terms of the following aspects:

- The outcome of this study will able to assess the public transport sector of Addis Ababa from different angles. Hence, the end result will give a comprehensive overview of the constraint as well as the potential that this mode of transport services offers.
- This study presents the general descriptive as well as inferential statistics of different variables, the overview and knowledge of factors influencing the choice of modes. Thus, by looking their relation to the mode choice of passengers, this paper is helpful to gain information and knowledge about transportation system in the city.
- The outcomes of this research can also be used as a spring board for further study in the city transport sector.
- This study is influential to provide the necessary resource in light of the possibilities of future urban transport intervention projects that might be proposed or even carried out.

1.6 Scope and Limitations of The Study

1.6.1 Scope of The Study

The core public transport services in Addis Ababa are Anbessa city bus, Minibus taxis, and the newly introduced Light rail transit. Therefore, this study considered these three services. The others modes of public transportation such as Higer bus, Sheger bus, Public bus, Aliance bus and other Taxi services are not included for the reason that they have less network coverage and lack of adequate information on their service routes.

As stated earlier, the services provided by Anbessa city bus, Minibus taxi and Light rail transit are extended to the study area. However, the main objective of the project is specific within Addis Ababa, services offered to location outside the city are not included. The limit of the study is along "Torehayloche - Maxico". However, the paper will limit itself to suggest recommendations that can make this sector's more efficient.

1.6.2 Limitations of The Study:

The most constraints of this study were:

- Financial limitation.
- Time constraint was also a limiting factor.

  Despite the study encounters these limitations, the study states all the findings by considering passengers choice on different modes and it helps to give attention for the case and further studies.

1.7 Organization of The Thesis

This study has five main parts

- ❖ The first chapter is the introductory section which covers background of the study, statement of the problem, research questions, objectives of the study, significance of the study and scope and limitations.
- ❖ Literatures by referring to various relevant books, publications and other related literatures concerning on transportation modes and passengers choice were reviewed in the second chapter.
- ❖ The third chapter covers methodology of the study.
- ❖ In the fourth chapter, data gathered through questionnaires and survey data are presented and analyzed.
- ❖ The final chapter presents conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

The purpose of this chapter is to give a general theoretical framework about the topic; it also aims to present general facts of the previous finding, ambiguities and arguments about the concept that has been researched.

2.1 Theoretical Framework

Transport plays a vital role in the development of the modern era as an integral part of the socioeconomic and political structure of the country. Thus urban transport, transport infrastructure, modes of transport and traffic management should involve optimal integration of the means of ways of mobility to create maximum ease and comfort maintaining the socioeconomic and physical integration of the city (Kottenhoff, 1999).

It is well understood that the modernization and urbanization processes accelerate the importance of this sector in providing accessibility and mobility reaches higher levels. Transport is an integral part of human life. According to the paper of Matas (2004), proper transport link enable efficient frequency services, flow of passengers and commodity on (rail, roads, air water) mode of travel. Transport theory (or the law) stresses strongly that whatever the mode will be, it should primarily consider the human aspect (i.e. safety, livability, economy, satisfaction etc.). This gives every individual the right to choose the services that he/she desires (Kottenhoff, 1999).

Transport and the different modes have evolved through time to where now in the quest accommodate the complex pattern of the world trade and globalization, its magnitude and efficiency in the distribution process is continuously being brought in to effect by technological and operational improvement (Forward, 1998a).

The urban transport system should be modified and structured to contribute and operate within the principles and limitations of urban development planning by simultaneously considering and weighing several socioeconomic, spatial and other perspectives in the problem solving process. Hence, an efficient urban transport system can only be realized and sustainable through planning which responds adequately to movements requirements and offers guidelines for better and efficient use of investment serving as invaluable input for spatial development policy (Alan Black, 1995).

2.2 Urban Transport

All types of means of transportation are used in urban areas. "It is commonly accepted that cities are the engines of growth in most developing as well as developed countries. More importantly urban transport can be viewed as the oil that prevents this engine from seizing up." (ORAAMP, 2010).

Transport is an essential element of city development that, in turn, is a major source of national economic growth. Simply stated, poor transport inhibits growth. It has also shown that, transport is the means of accessibility to jobs, health, education and social services essential to the welfare of the city residents. Deteriorating transport conditions affect all city residents; they impact particularly the poor through a decline in public transport service levels, increased length of the journey to work and other essential services and the negative impacts on environment, safety and security that the poor are least able to mitigate (World Bank, 2001).

2.2.1 Urban Transport Problem

Even though urban transport plays a big role in maximizing the rate of mobility of an urban population, it also has its own problems which are being observed in most cities. The urban transportation problems actually a complex bundle of inter related problems.

These problems can be grouped into three major categories: congestion, mobility and other ancillary impacts (Jakobsson, 2000).

A. Congestion

Congestion causes increased costs for travelers and freight movement, loss of time, accidents, and psychological strain (Alan Black, 1995). This is not simply congestion of transit vehicles during peak hours, congestion of pedestrian on sidewalks as well as congestion of bicycle. Congestion is neither a new phenomenon nor a role effect of automobile.

"As soon as the increase of population is created a demand for wheeled traffic in Rome, the congestion became intolerable. One of Julius Caesar's first acts on seizing power was to ban wheeled traffic from the center of Rome during the day..... Just as motor car congestion now affects small towns as well as big ones, so the increase of animal-drawn vehicles impeded circulation everywhere in Room. Hence, Claudius extended Caesar's prohibition to the municipalities of Italy; and Marcus Aurelius, still later, applied it without regard to their municipal status to every town in the Empire" (Matas, 2004).

Congestion is what most people find objectionable about traveling in cities. It is the most common complaint. If there were no congestion, most people would be happy with their cars, and transportation would not be a widely discussed problem.

According to Alan Blank (1995), Congestion has several generic causes as:

i. The first is urbanization-the concentration of people and economic activities in urban areas.
ii. The second cause is specialization within cities. People want to travel between different land uses, which are dispersed around the city Workplaces are

concentrated in some areas, living places in other areas, and recreation activities in still others. But these activities are interdependent, and people must travel between them.

iii. The third cause is the problem of matching supply and demand temporally. Demand, however, varies greatly over the day; this is the peaking problem. It stems largely from the Journey to work and the practice of having most people start and end their workdays at about the same time.

iv. A fourth cause of congestion is that supply often creates demand. Increases in transportation capacity can be self-defeating. A new highway that seems spacious when it opens may fill up with traffic in a few years.

B. Mobility

According to paper of Kottenhoff (1999), a new concept of mobility was introduced. It was shown that the level of mobility of a group of people is dependent on four main characteristics which are;

1. Traveling time budget of people.
2. Availability of transportation modes or services to the people.
3. The average speed at which the people can convey from one location to another by available modes.
4. The person carrying capacity of network of facilities.

Mobility requires, among other things, acceptable levels of environment impact, and costs of development and operation of transportation system etc.

C. Ancillary Impacts

The ancillary impacts of a transportation system or the externalities make up the third aspect of transportation problem. These are: land use, energy consumption, environmental impact, land consumption, aesthetics, accidents, and disruption of urban fabric. A detailed explanation of these impacts is given under the section that studies, the social impact of public transport system (Forward, 1998a).

Land Use: Fulfilling the resource requirements of a growing population, due to either migration or natural growth, ultimately requires some form of land-use change or urban expansion (urban sprawl) in order to provide for food, living space, recreation, infrastructure development and service provision. This in turn is easily manifested through the demand for a increased transport supply. However there has always been a major debate amongst land use and transport planners over which comes first, the development of land or the provision of transport. Does development follow the availability of road infrastructure and/or rail, bus or taxi transport or does intensified land used and developments occurs which results in the demand for improved transport (Matas, 2004).

Energy consumption: Transport is major and an increasing user of energy in modern society and road transport is responsible for a bulk of the energy consumed with in the transport sector. Darido (1975), identifies the combined effect of a number of factors that have contributed to increases road transport energy consumption as follows:-

i. Increases in the number of journeys resulting from the considerable growth in urban activities, and dispersion of the population.
ii. Increases in private vehicle ownership.

2.2.2 Urban Transport Modes

Urban transport is broadly categorized in to motorized or non-motorized modes. The choice of a particular mode of transport depends on such factors as accessibility, cost of travel, safety, travel time and the like. Non-Motorized modes include animal drawn mode, walking mode, and bicycle. Whereas motorized modes includes railways, air plane, and vehicular and motor cycle (Berge, 1998).

2.2.3 General Natures of Modern Public Transport

Various studies have classified modern public transport in to four general categories based on their nature of operation (Tuffa, et al., 2001). These are:-

1. **Buses and trolley buses:-** operate on public street in either mixed traffic or bus only lanes or exclusive bus ways. They employ engines that use fuel and or electric energy. Electric buses usually run with the help of cables that are mounted on electric poles which run along the whole line.
2. **Light rail transit Trains:-** operate in mixed traffic along public streets to semi-metro rail systems on exclusive trucks.
3. **Rapid rail transit (Metro, subways or underground) :-** operates on exclusively right-of-ways at high speed and high capacity passengers board from high-level platform to facilitate rapid loading.
4. **Sub-urban rail transit (Commuter rail system):-** operates on trucks shared with inter-city passenger crews and freight.

Urban Mass Transport systems can also be classified based on the line system they employ (Tuffa, et al., 2001).

A. On-street systems: buses; trolley-buses; trams.

B. Mixed on-street and off-street systems: bus lanes; bus ways; light rail.

C. Off-street systems: metros; commuter-rail.

2.3 Theories of Haw Passengers Choose Mode of Travel.

2.3.1 Introduction

This section deals with haw the travelers choose their mode of transportation. The attitude based theories will discuss to understand travelers mode choice behavior.

2.3.2 Attitude-Based Theories

Earlier research around commuters' choice of travel mode employed microeconomic theories and methods to map the individual's decision process. There are other theories or explanatory models, for example the attitude-based theories described below.

2.3.2.1 Theory of Planned Behavior

Attitude-based theory is the Theory of Reasoned Action formulated by Ajzen and Fishbein (1975), which tries to predict and explain human behavior. The theory deals with possible linkages between attitudes and behavior and it is assumed that people have a free choice. Forward (1998a), developed the theory to include the variable perceived behavioral control. This theory, the Theory of Planned Behavior (TPB), assumes that the choice is also dependent on the individual's perception of his or her ability to execute a certain behavior. TPB has made it possible to explain the choice of travel mode (Forward, 1998a).

According to TPB, people act rationally and decisions are considered consciously. The intention behind a certain behavior is dependent on three factors:

- the attitude toward the behavior

- the social norm
- the perceived behavioral control

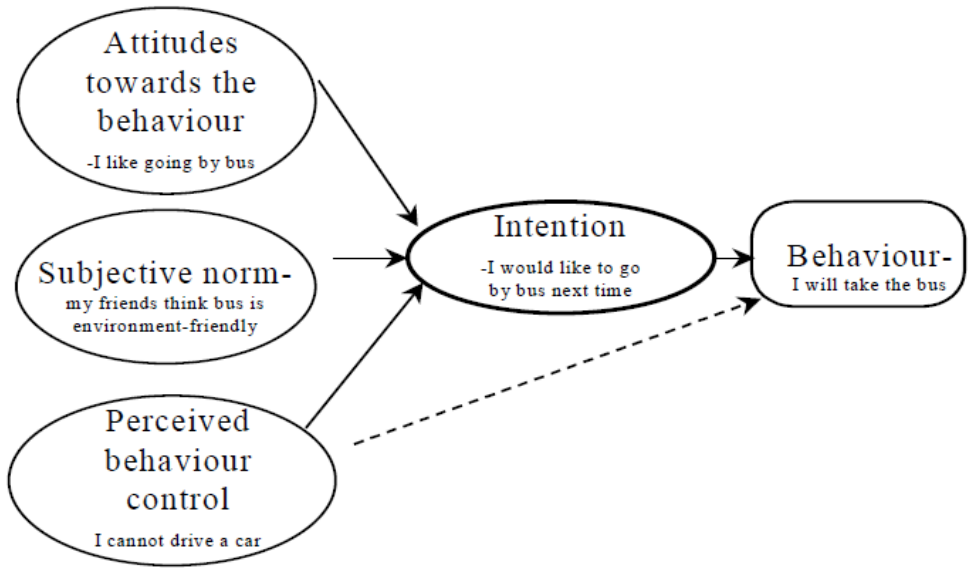

Figure 2.1: Theory of Planed Behavior (source: Kottenhoff and Lindsttrom, 2003).

Attitude: includes all important convictions related to the personal consequences of a certain behavior (e.g. travel by bus).

Social norms: are the product of normative convictions, which the individual's environment expects of him or her, and individual's motivation to adapt to these expectations.

Perceived behavioral control: is a function of control convictions, which in turn arise artily out of one's own experiences and partly indirectly, as a consequence of information, given by other people (e.g. how difficult someone believes it is to travel by train). The importance of the perceived behavioral control component itself and its value for predicting behavior have been confirmed by empirical studies (Garling, et al., 1997).

The variables are assumed to be independent of each other and the degree of explanation (their influence) varies between travel modes. According to TPB the effect of other

factors such as gender, age and personality will influence behavior, but indirectly, which means that the explanatory value of the model would not be greater if more variables were included. If we want to predict a specific behavior we must measure the attitude to just that specific behavior. An example: If we want to know whether a person will take the car or travel by public transport for their next journey to work, we have to ask about that person's attitude to that particular journey and not about public transport in general.

TPB shows that it is possible to change a person's behavior by influencing their attitudes, the subjective norm and their perceived behavioral control. If we want more people to travel by public transport, we can influence attitude, for instance by offering free test trips. This gives people personal experience. The subjective norm can be influenced by good examples such as celebrities and politicians showing that they travel by train and public transport.

2.3.2.2 Individual-Related Factors

Attitude factors

Attitude is important when choosing a mode of travel. By Attitude or routine we mean that an action takes place without considering other alternatives. Road users have a resistance or inertia to change and prefer the travel mode they currently use. The resistance is greater if there is a previous habit. According to this argument, it is easier to introduce a new behavior if the habit can be broken, for example when moving to a new house or job (Forward, 1998).

Several studies show that people's attitudes are important for the choice of travel mode. Others maintain that even if this is correct, attitudes are formed according to the actual choices travelers have made or have been forced to make due to the particular circumstances (Polat, 2012).

The age factor

Studies have shown that young people up to the age of 25 use public transport as their commuter trips (58%) after the age of 25 uses (83%) travel daily by public transports (Berge, 1998).

The lifestyle factor

There are linage between lifestyle and travel mode choice, access to a car, and attitudes. The analysis shows that there are differences between ages and gender, and if one lives in a rural area or in a town or city. The study also shows which groups are most meaningful to concentrate resources on to get them to transfer from the car to other modes of travel. The group that is easiest to influence is found to already use public transport to a large extent and the measures will therefore not have such a great effect on this group (Racca, et al., 2004).

Security factors

Security is important for choice of travel mode. Women priorities security on public transport more than men (Algers, et al., 1995). According to Algers, et al (1995), Women feels insecure on public transport to a greater degree than men. Almost a third of public transport passengers say that they are afraid of being threatened or attacked on their journey and many simply avoid travelling. Rowdiness and disorderly behavior on late night buss can be perceived as so worrying that a traveler will choose another travel mode. If part of a journey is perceived as unsafe, this can be decisive for the travel mode one chooses. If a traveler does not feel safe at the bus stop, perhaps he or she will choose to cycle or walk. If travelers do not feel safe on the way from home to the stop, they may prefer to travel by car.

A study of Forward (1998) indicates that, there is a willingness to pay for guard patrols on underground stations. The behavior of other passengers affects comfort. This became more important the more one travelled by bus or when the person question was a woman. Travelers over the age of 60 feel more insecure than younger people and people with lower levels of education seem to be more afraid than people with higher education. Getting to and from stations and bus stops is in general perceived as more insecure than the journey itself. There appears to be a difference in the perception of security depending on how often one travels by public transport. People who travel more seldom feel more insecure. The Traffic and Public Transport Authority has made calculations of the consequences of people feeling insecure in the public transport system. About 4% of people between the ages of 18 and 74 living in Gothenburg refuse, due to the feeling of insecure, to travel by public transport once a week or more.

The Gender factor

The difference between women and men depends on how work at home is divided among the household. Women still take greater responsibility for children and the home. Driving to the shops, and driving and fetching the children constitute a large portion of women's total mobility.

Several studies show that women and men make different travel mode choices and have different travelling patterns. Men ravel longer distances regardless of the weekday (Calsson-Kanyama, et al., 1999).

Another difference is that men spend their leisure time outside the home more often than women. The survey shows that women visit museums and go to exhibitions and concerts more; activities that take place more seldom than men's sports activities. Studies show that if a woman and a man have the same income, the man is first to buy and own a car to

a greater extent than the woman. For women the figure is 5%. Men use the car more than women do and use the transport system more during rush-hour than women. 60% of all public transport journeys are made by women. Women are less mobile in so far as they do not move so far from home, and their journeys often start and end at the same point, and are often related to the home or family members. Men tend more to value and choose travel modes that are individual (Racca, et al., 2004).

One explanation for the difference between women's and men's choice of travel mode is that women's workplaces are traditionally located closer to home than men's. A man will often have his workplace in production of some kind, while a woman's will tend to be in the public sector. Carlsson-Kanyama (1999) maintains that, men's working places are located on the outskirts of towns and cities where public transport is insufficiently developed and that it is more convenient for women to travel by municipal transport than for men because of the locations of their workplaces.

At the same time, other studies show that public transport is not adapted to women's travel patterns of doing errands on the way and working irregular hours, e.g. in the nursing sector. More women than men say that they have a positive attitude to public transport (Berge, 1998). Other differences are that women more often value personal security and environmental aspects.

2.3.2.3 Criticism of Attitude Based Theories

People do not always act as they say they will. Kottenhoff (1999) qualitative studies of travel mode choice indicate that, changes in behavior lead to changes in attitudes. The respondents felt that it was their changed behavior that caused them to change their attitudes, not the other way around. According to Kottenhoff (1999), attitudes' value for predicting actual behavior is poor, because they are collected through interviews or

questionnaires. The same complex of problems also applies to Stated Preference interviews. It is important when asking attitude questions to base them as far as possible on the individual's experience. Another shortcoming is that attitude-based theories are not easy to use to predict what happens when the standard of the service, for example travelling time, changes.

2.4 Some Ways of Classifying Factors That Affect The Choice of Travel Mode.

The choice of travel mode is affected by a great many factors, everything from transport-specific factors (describing the various components of the transport system) to socio-economic factors such as a person's attitudes and habits (Domencich, 1975). These factors are classified in many different ways in the literature. Some of these are described below.

2.4.1 Hard and Soft Factors

Some researchers have chosen to divide the factors into hard and soft factors, where hard factors are easier to quantify than soft ones. Hard factors are normally found in the traditional travel mode choice models that are based on maximization of utility. Examples of hard factors are travelling time, waiting time and ticket price (fare). Soft factors are things like comfort, service and information (Kottenhoff, 1999).

Transport fares are essential to the supply of public transport service since they serve as the main source of the income of the operators. The relationship between fares and public transport patronage tend to be inverse, where higher fares seem to be associated with decreased patronage and vice versa (Racca, et al., 2004). However, it could be observed that the effect of fares on patronage is not similar in all public transport modes and in all time frames. The factors that characterize travel demand in Mexico City, found that changes in fares did not explain changes in demand in Mexico City. The study detected

that rather service improvements had a more significant effect on public modes transport (Crotte, 2008).

Travel time has been seen as one of significant factors that influence both the choice and the use of public transport mode to the other. It's important is as a result of the fact that the travelers cannot increase their travel time indefinitely (Golob, et al., 1972). According to Polat (2012) travel includes "several components within the public transport frame. Walk (or access) time, waiting time and journey (in-vehicle) time are the three main components of travel time. Each of these components has different value for travelers". In Horn (2003) view "for a typical public transport user, the price includes many of these cost components including access time to service points and final destination, waiting times at stops and travel times at a vehicles which in its entirety influence the travelers".

In a publication by FitzRoy and Smith (1998), it was argued that service quality is another important transport variable in terms of transport service patronage with the most direct and powerful influence in public transport service. Service quality includes but not limited to waiting time, service frequency, operating speed, reliability and comfort. Although the degree of importance given to comfort may differ from one group of passengers to another based on the journey time, journey purpose and passengers type, comfort is a quality factor that should be taken into account. Comfort is expected to positively affect demand (Polat, 2012).

Another point to consider is the degree of overcrowding in vehicles. Overcrowding can be expected to affect comfort and invariably create unpleasant and uncomfortable conditions. The researcher of this paper are of the view that seating arrangements in the vehicle and leg-room space as well as general vehicle cleanliness are other aspects of comfort a vehicle should provide. Koppelman and Lyon (1981) stress that, people's perceptions about convenience and comfort as well as their normative beliefs correlate

positively with preference and hence the choice for a given mode of transportation. Another point to consider is the degree of overcrowding in vehicles. Overcrowding can be expected to affect comfort and invariably create unpleasant and uncomfortable conditions. The researchers of this paper are of the view that seating arrangements in the vehicle and leg- room space as well as general vehicle cleanliness are other aspects of comfort a vehicle should provide. Koppelman and Lyon (1981) stress that people's perceptions about convenience and comfort as well as their normative beliefs correlate positively with preference and hence the choice for a given mode of transportation. It is even thought that elements with the most physiological importance to comfort are those which affect quality of a ride as well as the effort of driving such as noise, vibration, ventilation, glare, odor and seating arrangement (Neumann, et al., 1978). Existing literature also tends to suggest that choice of mode for various trips is either directly or indirectly influenced by people's personal circumstances including their age, gender, household size, educational attainment and income (Buchanan, et al., 2006). Perceptions of safety as well as travel experience with a particular mode of transport are likely to influence travel decisions and preference for one mode from the other (Ankomah, et al., 1996).

2.4.2 Internal and External Factors

Factors that control choice of travel mode can also be divided into internal and external factors. Internal factors include attitudes, socio-economic and demographic factors, habits and perceived level of control. External factors include such things as travelling time and the cost of the journey (Forward 1998a).

2.4.3 Subjective and Objective Factors

Another way, used by Domencich (1975) is to divide the factors into subjective and objective factors. The objective factors are normally based on objective measures and are easy to measure and quantify. Domencich counts the alternative's so-called hard standard factors, travelling time, fare etc, and soft standard factors such as comfort, information etc, as objective factors. The objective factors also include socio-economic factors such as gender and age, and also trip-related factors such as purpose. Examples of other objective factors are weather, topography, security and environment. Subjective factors here include valuations of the alternative's characteristics, attitudes and lifestyle. These factors are based on the individual's perception and are often more difficult to quantify.

According to Domencich (1975), the subjective and subjective issues are described as follow:

A) The ability cope with passengers demand. The selected mode should be able cope with the estimated volume of passengers expected to use the route. This also depends on the corridor width available to the route. If the mode can't carry the passengers demand within the corridor space available, then either the more effective mode should be used.

B) Cost

The cost of moving passengers can be considered in many ways; namely:

- The total cost per passenger in KM; since this will reflect the financial cost of the service.
- The capital cost; since this will be amounted fund that will be sourced before the service introduced. The question arise wheatear the local economy or government fescues has the resource to fund the investment.

- Capital cost/operating cost ratio; bus service has a ratio of the order of 16% whereas rail project have a ratio of 76%.
- The sensitivity of the project to capital overturns and overestimate in passengers number.
- The percentage of cost recover; since this indicate the amount of subside the service will require from the government.

C) Environmental conditions

Aspects such as noise, air pollution as well as the projects visual intrusion; and conception of energy.

D) Saving in journey time. The magnitude of this savings will depend on the number of passengers and the value placed on the time saved by each passenger. Most passengers on transit are commuters making non-business trip. Some authorities consider that there is no value should be placed on time saved on non-business trip. Some authorities consider that there is no value should be placed on time saved on non-business trip; while others suggest that it is equivalent to 25-35% of the income earning rate.

E) The expected relative safety of each mode; usually expressed as the expected number of fatalities, injures or collisions. These parameters would need to be defined on a per passenger or per passenger - km bases.

F) The objective aspects include the following;

- **Comfort** of the passengers.
- The **connivance** of accessing the mode.
- The number of mode/vehicle **interchanging** required.
- The **reliability** of the modes in operation.

- Problem with **fair evasion** and revenue linkage.
- The **sophistication** of the operation and system maintenance.
- The **complexity** of implementation.

2.4.4 Classifications of Trip Standard Factors

For public transport, Golob(1972), divides the transport-related attributes that describe the travel standard into individual specific factors and transport specific factors.

Individual specific factors

An individual specific factor consists of factors that describe not only the individual and the individual's characteristics but also, to a certain degree the whole household. such factors include socio -economic factors such as age, gender, household size, occupation, Marital status, educational attainment and income (*Forward, 1998).*

Transport specific factors

Transport specific factors are sometimes in the literatures called standard or basic factors that influence the choice of modes.

Many studies show that traveling time and fare are crucial to the choice of travel mode and the decision to travel at all (Algers, et al., 1995). Kottenhoff (1999) showed that, the level of comfort and service ware also very important for the choice of public transport modes.

Another point to consider is the degree of overcrowding in vehicles. Overcrowding can be expected to affect comfort and invariably create unpleasant and uncomfortable conditions. Comfort is expected to positively affect demand (Polat, 2012).

2.5 Statistical Analysis

2.5.1 Discrete-Choice Models

Discrete-choice models have been developed to investigate factors influencing travel choice. The common theoretical base is random utility theory (Ortuzar, et al., 2001). In another way, it assumed that individual always choose the alternatives with the highest utility and that there is random part that cannot be observed by the analyst. The model offer a sophisticated analysis of haw various factors influence the choice of mode and the trade-offs people make between these factors. A discrete-choice model predicts a probability by an individual as a function of any numbers of factors that describe the alternatives. Discrete choice models can be based on either observed behavior (Revealed Preference data) or on hypothetical choice surveys Stated Preference data (McFadden, et al., 1975).

The two most popular discrete-choice models are multinomial logit and nested logit models (Ortuzar, et al., 2001).The mixed logit and random effects are also models becoming more and more common. Logit models are mathematical models that are widely used to describe the way individuals choose different alternatives (Ben-Akiva and Lerman, 1985). These statistical mathematical models combine different factors of the choice process. Logit models are used also to estimate the effect of different measures. Through the model, it is also possible to understand the individual's choice based on number of factors that are thought to influence the choice of behavior.

2.5.2 Ordered logit model

The ordered logit model is a regression model for an ordinal response variable. The model is based on the cumulative probabilities of the response variable: in particular, the logit of each cumulative probability is assumed to be a linear function of the covariates

with regression coefficients constant across response categories. Questions relating to satisfaction with life assessment and expectations are usually ordinal in nature.

Example, the answer to the question on how satisfied a person is with her quality of life can range from 1 to 10, with 1 being very dissatisfied and 10 being very satisfied (e.g. Schaafsma and Osoba, 1994; Anderson *et al.* 2009). It is tempting to analyze ordinal outcomes with the linear regression model, assuming equal distances between categories. However, this approach has several drawbacks which are well known in literature (see, for example, McKelvey and Zavoina, 1975; Winship and Mare, 1984; Lu, 1999). When the response variable of interest is ordinal, it is advisable to use a specific model such as the ordered logit model.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter concerns about the methods that were used for collecting data. It mainly explains how the study was conducted, the applied methods and techniques in data collection and the reasons as to why they were used according to the research aimed by considering objectives of the study. This chapter involved discussion of the research process, the selection of the study area, sampling method and justification and sources of data used in the study.

3.2 Study Area

Addis Ababa is the capital and largest city in Ethiopia. Addis Ababa has the status of both a city and a state. It is where the African Union and their predecessors the AU are based. It also hosts the headquarters of the United Nations Economic Commission for Africa (ECA) and numerous other continental and international organizations. Addis Ababa is therefore often referred to as "The political capital of Africa" for its historical, diplomatic and political significance for the continent also a home of African Union having important United Nations branches and with nearly every foreign embassies from around the world represented.

According to CSA (2007), it has a population of 3,384,569, with annual growth rate of 3.8%. The number has been increased from the originally published 2,738,248 figure and appears to be still largely underestimated.

Based on UNECA (2012) report, the city is a cultural mosaic of all Ethiopian ethnic groups due to its position as capital of the country. Addis Ababa contributes a lot to the

economic development of the country and it is where most significant changes in the socio-political sphere of the land emanate from. Addis Ababa has been manifesting to be the fastest growing city in recent decades and contributes about 40% to the national GDP.

Addis Ababa lies at an elevation of 2,300 meters (7,500 ft) and is a grassland biome, located at 9°1′48″N and 38°44′24″E coordinates: The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash. From its lowest point, around Bole International Airport, at 2,326 meters (7,631 ft) in the Entoto Mountains to the north.

The distance between Torhayloche to Mexico is 2.5 km, and Torhayloche is located at 9°00′34.6″N and 38°43′14.3″E as well as Mexico located at 9°00′37.0″N and 38°44′40.2″E.

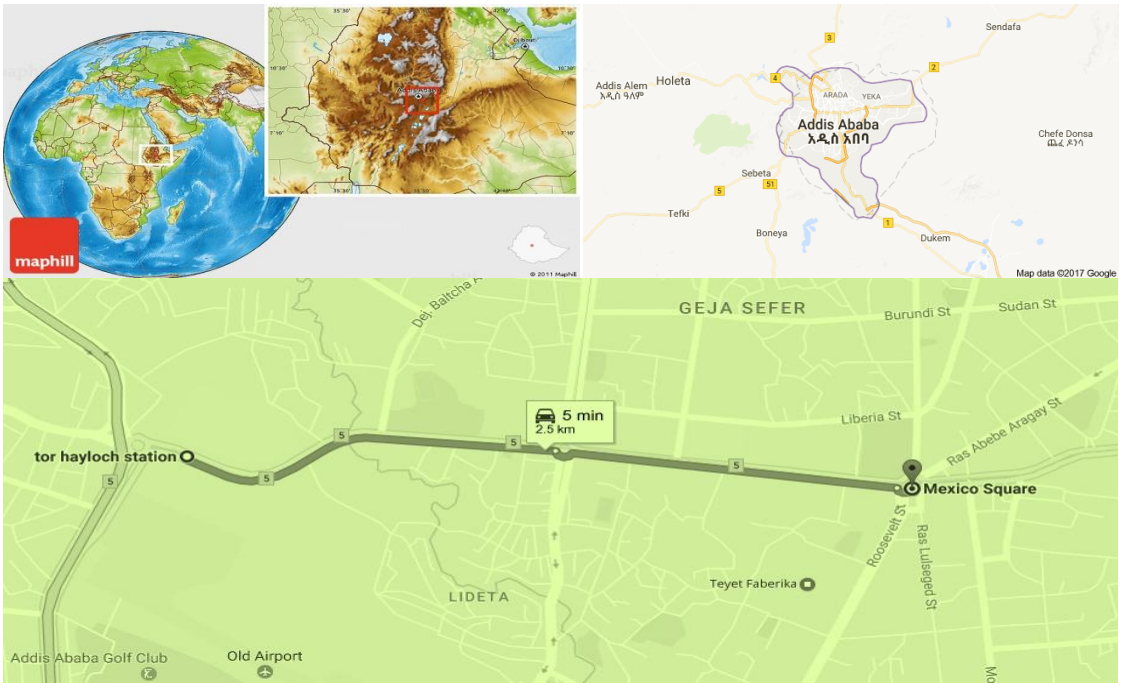

Figure 3.1: Map of Study Area (source: http://www.google map.com)

3.2.1 Case Study as a Research Strategy

This study covered assessment on passengers' choice of transportation modes along the East-West axis from " Torhayloche - Mexico ", which is one of the busiest and the most

congested route in the city. According to Addis Ababa transport authority Ledeta branch report, nearly 33,627 passengers use this route per a week. The other reason is a study made by researchers on this axis is available.

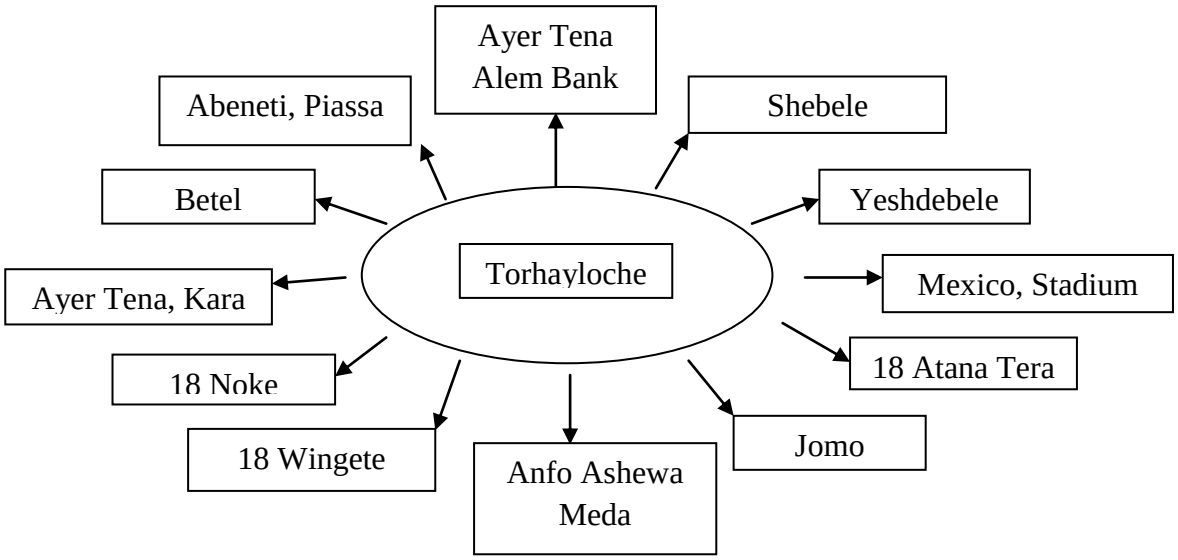

Figure 3.2: Information on The Study Area

3.3 The Research Process

The methodology and procedure for data collection employed in the field was based on questionnaire, observations and review of secondary data, were done accordingly.

3.3.1 Primary Data Gathering Tools

The primary data for the analysis was basic method for this research and it obtained in two major ways:-

1. Questionnaire Surveys

I. These were conducted on subjects passengers, for who were relying on the public transport sector, the City bus, Rail transport and the Minibus taxi, along the study area. Here special emphasis was given to the particular times of the day when the sample were taken, i.e. surveys were conducted both on and off peak hours. Furthermore, deliberate focus was given to such major public transport transit areas as Torhayloche, Cocacola, St. lideta, Tegbared and Mexico.

II. The conditions under which this sample questionnaire was surveyed had varying characteristics. This was done in order to get a real feel of the public transport system in operation. To this end, samples were taken of subjects actually taking a ride on different modes, others waiting in line for one to come and still others on early morning to get a transport.

2. On Site Observations

Surveys were made with subjects under varying circumstances such as taking bus rides, riding in mini bus taxis and riding in rail way, waiting in line for a bus, taxi, train to come, walking the route for field observation. The survey was carried out by the help of data collectors that were given adequate brief explanations in order to enable them conduct their survey efficiently.

3.3.2 Secondary Data

The secondary data was mostly obtained from such sources as published and unpublished documents collected from Addis Ababa City Transport Authority, CSA and different research paper studied by the former office for the revision of Addis Ababa master plan (ORAAMP).

3.4 Sampling Method and Sample Size

The study was adopted simple random sampling techniques and in order to determine the sample size according to Singh (2014), the following formula were used.

$$n = \frac{(Z)^2 x(p) x (q)}{e^2}$$

In which;

n = Sample Size

z = Z-value (1.960 for a 95 percent confidence level)

P = Probability of success (p), expressed as decimal

q = 1-p

e = Margin of error, expressed as decimal

Therefore, $n = ((1.960)^2 \times 0.5 \times 0.5)/0.0517^2$

$= 0.9604/0.002675$

= 359 passengers

Sample Survey by Destination

A total of 359 passengers were included in this study from public transport modalities, namely the Anbessa City bus, Minibus taxis, Light rail transit. It was undertaken throughout different locations of the study area.

Table 3.1: Sample Surveys of Various Locations on The East-West Axis (Torhayloche - Mexico).

Destination	Torhayloche	Cocacola	St. lideta	Tegbared	Mexico	Total
No. people	104	34	61	70	90	359
Percent (%)	28.95	9.47	16.99	19.49	25.1	100

Source: survey data, 2017

3.5 Data Analysis

The data collected from the field was first cross-checked and edited to ensure the data were given relevant for the purposes of the study.

The data were coded and fed into the computer. The Statistical product for Service Solution (SPSS version 16) was employed to process and analyze the questionnaires.

3.5.1 Method of Statistical Analysis

The methods of data analysis were used based on the nature of the variables incorporated in the study. The data type of the major variable is studied come up at the end of the study. Descriptive statistics and inferential statistics are the two broad categories of statistics used in this study.

3.5.1.1 Descriptive Statistics

It deals with any methods or procedures used to organize masses of numerical data in to a meaningful form. It includes the collection, organization, summarization and presentation of data using various methods such as charts, graphs and frequency tables (Polit, 1996). Descriptive statistics were used to describe and summarize the socio-economic as well as transport related factors of the passengers in this study.

3.5.1.2 Inferential Statistics

It deals with data from sample to make inference about the population from which the sample is drawn. It is the procedure by which to reach a conclusion about population on the information contained in the sample drawn from the population (Menard, 2002). The inferential analyses involved in this study were chi-square test of independence and multinomial logistic regression.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter discusses the major findings of the data collected through different methods stated under methodology. In this part field survey and questionnaire were mainly incorporated and an attempt was made to give a response to the research objectives. Basically the discussion and analysis were categorized into two main parts such as field observations and statistical analysis.

4.1 Field Observations

Surveys were made with subjects under varying circumstances such as; taking bus rides, riding in minibus taxi and train, waiting for bus, taxi, and train in line. Walking the route for field observations, discussing with different stockholders and road users, and the like.

4.1.1 Light Rail Transit

Trains in along (East-West) line, they are green and white and the fares cost from Torhayloche to Mexico route is 2 Ethiopian Birr. Service frequency was 10 minutes during peak hours and 7 minutes during off-peak hours. Along this route there are five terminals that are Torhayloche, Cocacola, St,lideta, Tegbarede and Mexico. For loading and unloading purpose of passengers, on each five stations 20 to 30 seconds were used. Since, Torhayloche station is the starting and ending terminal, once the train reached in the station it took 10 minutes to start the trip. Thus, the total travel time that the train finalized this route was 9 minutes. Addis Ababa Light rail was originally planned to have a capacity to carry about 286 passengers but it serves more than 300 passengers per a trip. Due to overcrowding, the Addis Ababa people still faced uncomfortable trips.

Figure 4.1: Addis Ababa Light Rail Transit (source: servey data, 2017)

4.1.2 Anbessa City Bus

From public transport services in Addis Ababa, the fare of Anbessa city bus is the cheapest one. For the trip from Torhayloche to Mexico the fare cost is 1.25 Ethiopian Birr. The service frequency was 20-30 minutes. And 19 -15 minutes required to finalize the trip during peak and off-peak hours respectively.

For a single bus that had high passengers carrying capacity 100 which means 30 seated and 70 standing passengers and double for the articulated one. There was unpleasant and uncomfortable conditions because of overcrowding. It is even thought that elements with the most physiological importance to comfort are those which affect quality of a ride as

well as the effort of driving such as noise, vibration, ventilation, glare, odor and seating arrangement were too difficult to travel as it was observed during field investigations.

Figure 4.2: Anbessa City Bus (source: survey data, 2017)

4.1.3 Minibus Taxi

The blue Taxis are pretty much familiar and affordable means of transportation with the Addis Ababa passengers. Along the route Torhayloche to Mexico the travelers were highly dependent on Taxies as a mode despite high fares (Taxis are the most expensive means of transportation when compared with buses and trains), particularly for the low-income group (i.e., the urban poor). Thus, the fare cost using minibus taxi along Torhayloche to Mexico route is 2.75 Ethiopian Birr. The frequency of minibus taxis was high, but still it is insufficient for the passengers due to imbalance between demand and

supply. The Taxis were only spent 5-7 minutes if there was no problem on loading and unloading and off peak hours but on peak hours specially at morning and evening time there was high traffic jam so that it took about 12-15 minutes to finalize this route. Even if the official carrying capacity of minibus taxi is 12 passengers, more than 18 were using. This created uncomfortable movement for the passengers.

Figure 4.3: Minibus Taxi (source: survey data, 2017)

4.2 Statistical Data Analysis

The analysis is carried out in to two parts. In the first part, results of descriptive statistics are presented. In the second part, multinomial logistic regression model was employed to identify and examine determinants of mode of transportation choice with the help of SPSS software package.

4.2.1 Results of Descriptive Statistics

A total of 359 passengers were included in this study. The sampled data were collected by interview face to face on their important background characteristics for the study. From the sampled data, (28.97%) of the passengers' choices were Minibus taxi, (43.45%) of their choice were Light rail transit and the remaining (27.58%) of the passengers' choice were Anbessa City bus. In addition, this can be seen graphically as follow.

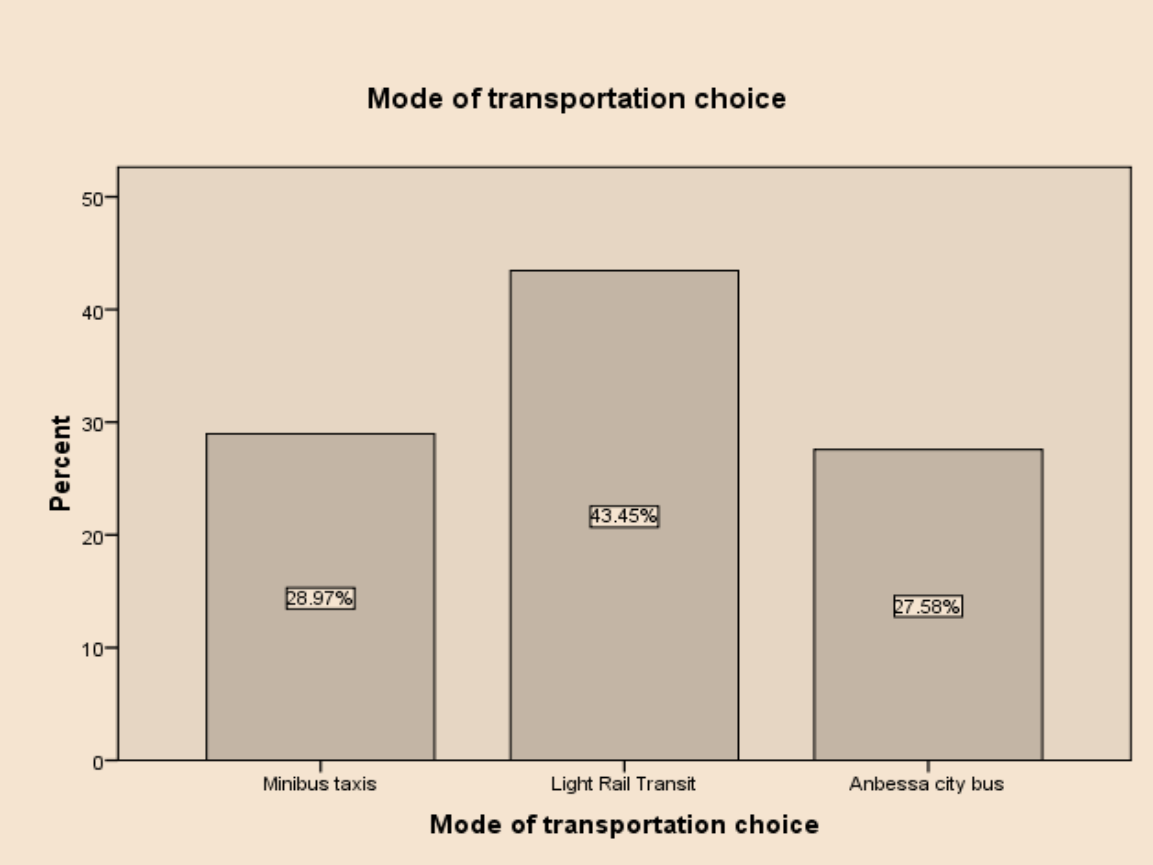

Figure 4.4: Mode of Transportation Choice

Table 4.1 shows that among the total passengers, (60.4%) of them were males and majority of their choice were Light rail transit (49%). The remaining (39.6%) of the passengers were females and (43.0%) of their choice were Minibus taxi. As studies showed that public transport is not adapted to women's travel patterns this is because women still take greater responsibility for children and the home and from those public

transport users the majority of them are not using bus and train this is of course supported by this research. And their choice among modes can be expressed graphically as follow.

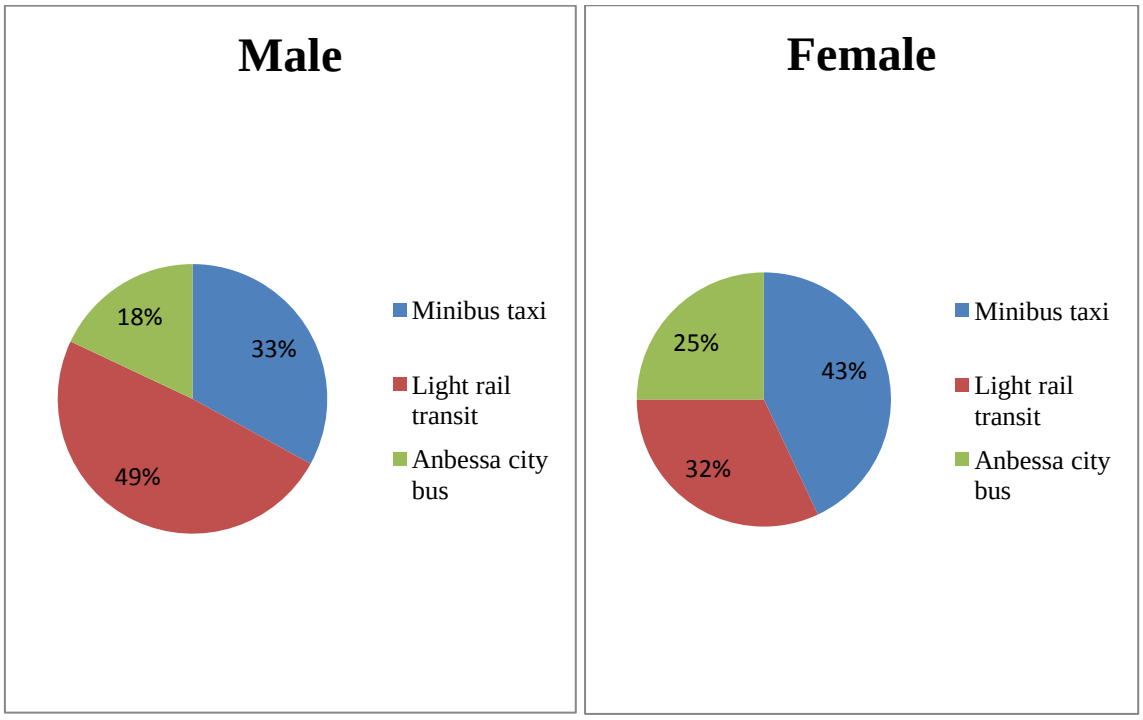

Figure 4.5: Percentage Distribution of Each Transport Mode Based on Sex

According to Table 4.1, age of the passengers was another determinant factor. Among the total, the proportion of passengers highest among age between 18-25 years (38.4%) and majority proportion of passengers were at this age group choices were Light rail transit (47.8%) followed by those whose choice were Minibus taxi and Anbessa city bus (26.8%) and (25.4%) respectively. And the lowest proportion of passengers was observed at teenage passengers, the age range less than 18 years. Studies have shown that young people up to the age of 25 are highly dependent on public transport than after the age of 25 and this is again true in this research.

Table 4.1 also shows that occupation status of passengers were the other factor and the highest proportion of passengers was recorded among individuals who were employee (56.8%) followed by those whose occupation were students (43.2%). The highest

percentage were observed at passengers choice on Light rail transit transportation mode at both occupation type (48.4%) and (39.7%) of students and employee respectively was recorded.

Similarly, Table 4.1 shows that, the proportions of passengers mode of transportation choice varied by education level. Majority of passengers (65.2%) of them had above secondary education level. When, only (15%) and (19.8%) of them had primary and secondary education level respectively. The highest proportions of mode of transportation choice in all education level were Light rail transit. A study of Forward (1998), indicates that people with lower levels of education seem to be more afraid (feels insecure) than people with higher education to choose public mode of transportation. And this is agree with what was observed in this study, since majority of public transport users had above secondary education level.

The proportion of passengers was highest among their income range between 4001-6000 birr (33.7%) opposed to the lowest income level which was recorded in income group greater than 6000 birr per month (6.4%). Among the income group greater than 6000 birr about (84.0%) of their mode of transportation choice were Minibus taxi compared to passengers income less than 2000 birr (15.0%). And their choices among modes can be expressed graphically as follow.

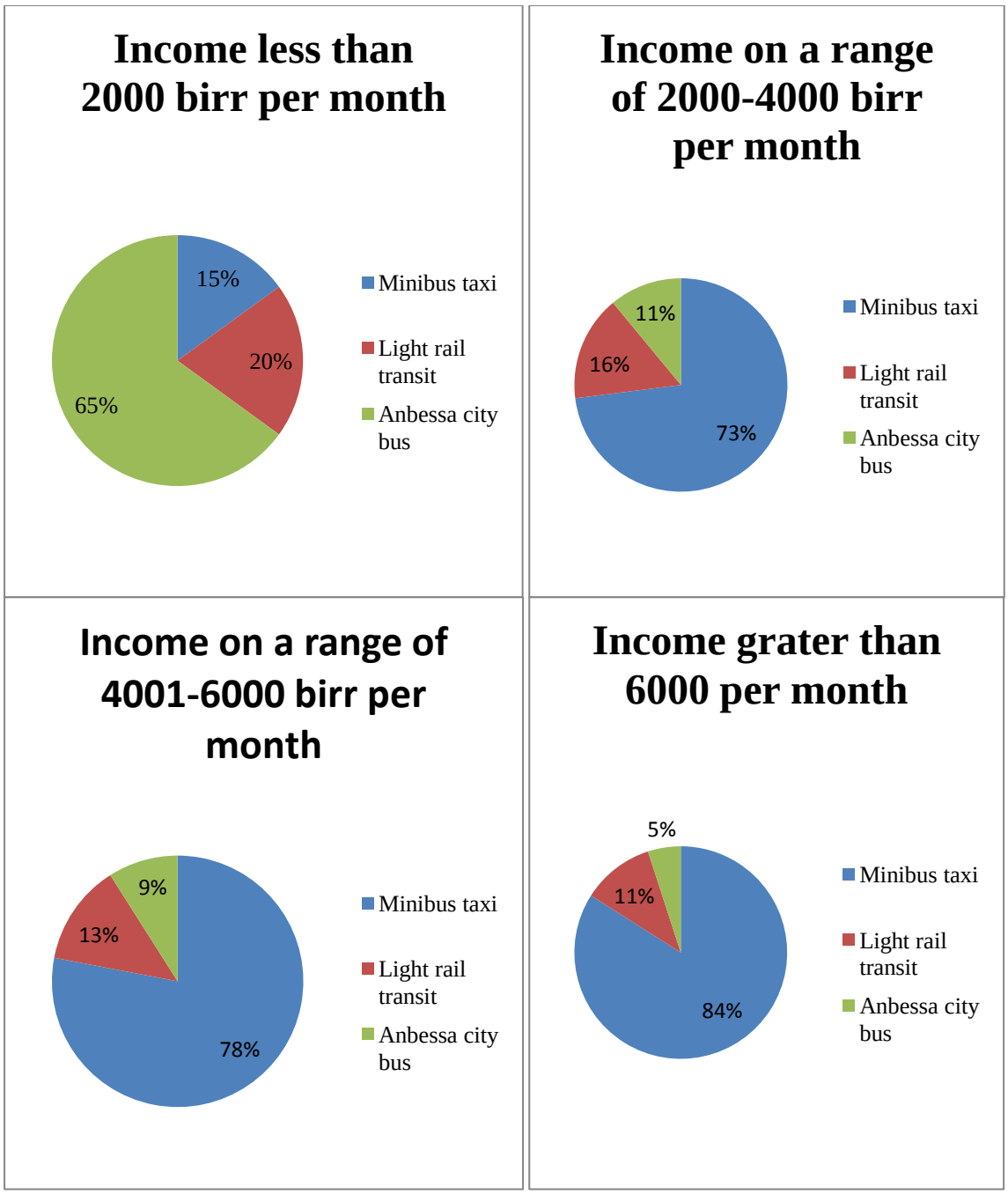

Figure 4.6: Income of Passengers With Mode Choice

Furthermore, among the total passengers, (28.1%) of them considered the fare of transport and from them (98.0%) selected Anbessa city bus, (2%) selected Light rail transit and no one selected Minibus taxi. Similarly, from the total passengers, (29.0%) of them considered comfort as a selecting factor and out of them (99%) selected Minibus taxi, (1%) Light rail transit and no one selected Anbessa city bus. From the total

passengers, (42.9%) of them considered travel time as a major selecting criteria and among them (98%) selected Light rail transit, (1%) selected Minibus taxi and (1%) select Anbessa city bus. Additionally, this can be seen graphically in the following figure.

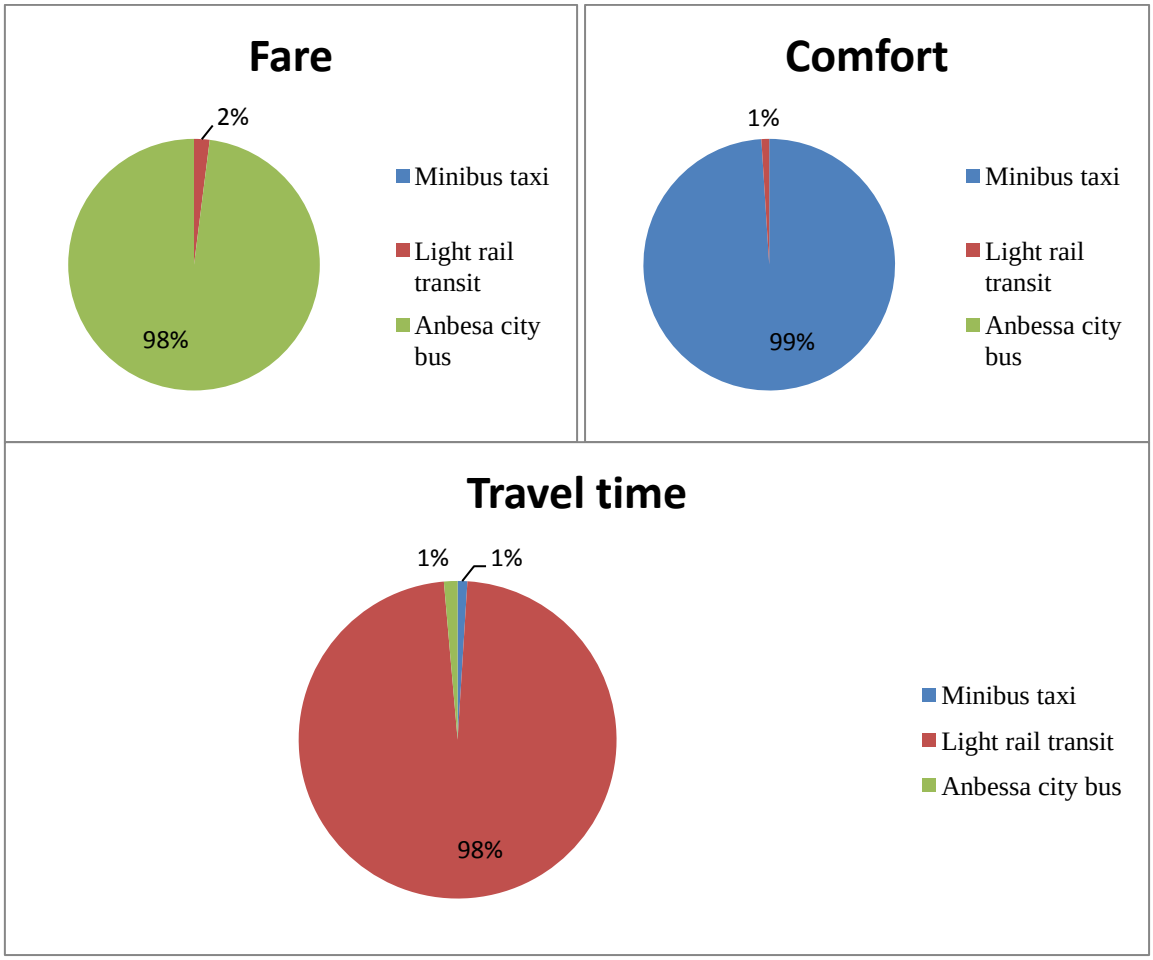

Figure 4.7: Percentage Distribution of Transport Related Factors With Mode Choices

Table 4.1: Descriptive Summary of Mode of Transportation Choice With Related Factors

Variable	Categories	Counts (%)	Mode of Transportation Choice		
			Minibus Taxi	Light Rail Transit	Anbessa City Bus
Sex	Male	217(60.4)	33.0%	49.0%	18.0%
	Female	142(39.6)	43.0%	32.0%	25.0%
Age	< 18 years	16(4.5)	25.0%	43.8%	31.2%
	18-25 years	138(38.4)	26.8%	47.8%	25.4%
	26-50 years	125(34.8)	36.8%	37.6%	25.6%
	>50 years	80(22.3)	21.2%	45.0%	33.8%
Occupation	Student	155(43.2)	36.8%	48.4%	14.8%
	Employee	204(56.8)	23.0%	39.7%	37.3%
Education Level	Primary	54(15.0)	24.1%	48.1%	27.8%
	Secondary	71(19.8)	25.4%	38.0%	36.6%
	Above secondary	234(65.2)	31.2%	44.0%	24.8%
Income per month	<2000 birr	103(28.7)	15.0%	20.0%	65.0%
	2000-4000 birr	112(31.2)	73.0%	16.0%	11.0%
	4001-6000 birr	121(33.7)	78.0%	13.0%	9.0%
	>6000 birr	23(6.4)	84.0%	11.0%	5.0%
Transport factors	Because it has less fare	101(28.1)	0.0%	2.0%	98.0%
	It’s comfortable	104(29.0)	99.0%	1.0%	0.0%
	It has less travel time	154(42.9)	1.0%	98.0%	1.0%

4.2.2 Inferential Statistics

4.2.2.1 Chi-square Test

Table 4.2 shows that the chi-square test results of multinomial analysis. Based on results presented in the table below, the predictor variables (factors) including sex, income, transport factors to choose transportation mode, were found to have a significant association with choice on mode of transportation at 5% level of significance.

Table 4.2: Test of Association Between Mode of Transportation Choice and Significant Factors

Factors	Chi-square	df	P-value
Sex	6.87	2	0.032
Age	23.31	2	0.412
Occupation	9.12	2	0.100
Education level	21.77	4	0.101
Income	420.50	6	0.001
Transport factors	695.00	4	0.000

4.2.2.2 Multinomial Logistic Regression

In order to develop a multinomial logit model, the following assessments of fit model were performed.

Model Fitting Information

Under Model Fitting Information result shown in Table 4.3, we see that -2Log Likelihood statistics for final model is 10.057. This statistics show us how much improvement is needed before predictors provide the best possible prediction of the response variable, the smaller the statistics the better the model. The result ($\chi^2 = 740.541,\ \mathrm{d.f} = 12,$ p-value<0.05), shows that the model is adequate, meaning that at least one of the predictors is significantly related to the dependent variable. That is, the null hypothesis is that there is no difference between the model with only a constant and the model with independent variables was rejected. Therefore, the existence of a relationship between the independent variables and the dependent variable was supported. Thus, their exist a strong interrelation between the dependent variable (mode of transportation choice) and the independent factors (Variables) it is possible to continue other Goodness of Fit requirements.

Table 4.3: Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	750.599			
Final	10.057	740.541	12	.000

Goodness of fit Test

Table 4.4 shows that goodness of fit test. The null hypothesis stated that the model was fitted well in Pearson and Deviance chi-square. And the result does not reject the null hypothesis since p-value for Pearson and the Deviance chi-square tests are greater than 0.05 level of significance. Therefore, it indicates that the model fitted the data well.

Table 4.4: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	4.508	16	.998
Deviance	5.508	16	.993

Pseudo R-Square

Two additional descriptive measures of goodness of fit presented in the Table 4.5 below are R^2 indices defined by Cox and Snell (1989) and Nagelkerke (1991). These indices are variations of the R^2 concept defined for the ordinary least square regression model. The Nagelkerke R^2 was 98.8% indiacating that the explanatory variables were useful in predicting mode of transportation choice.

Table 4.5: Pseudo R-Square

Cox and Snell	.873
Nagelkerke	.988

Likelihood Ratio Tests

The result displayed in Table 4.6, there is a statistically significant relationship between the predictor variables like sex, income and transport factors to choose transportation mode with the dependent variable (Mode of transportation choice). Since, the p-values for these variables are 0.010, 0.023 and 0.000 respectively, it's less than 0.05 level of significance.

Table 4.6: Likelihood Ratio Tests

	Model Fitting Criteria	Likelihood Ratio Tests		
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	10.057[a]	0.000	0	.
Sex	19.177	9.120	2	.010
Income	22.243	14.673	6	.023
Transport factors	348.580	338.522	4	.000

4.2.2.2.1 Results of Multinomial Logistic Regression Analysis

Multinomial logistic regressions were used to analyze the effect of each independent variable on mode of transportation choice, while controlling for the other independent variables. According to the result; sex, income and transport factors to choose transportation mode were found to be significant predictors for the determination of Mode of transportation choice at 5% level of significance.

A) Minibus Taxi Users Relative to Anbessa City Bus

This is the multinomial logit estimate for choice modes of transportation were Minibus taxi relative to Anbessa City bus, when the predictor variables in the model are evaluated at zero. For passengers who were male on the sex category were evaluated at zero with the first three categories of the income level and the first two categories of transport

factors to choose evaluating at zero the logit preferring Minibus taxi relative to Anbessa City bus was 1.089.

The logistic model showed that the likelihood of choice mode of transportation were Minibus taxi had significantly associated with sex (p-value < 0.05). Passengers who are male relative to female on sex category were 2.939 times more likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model.

Table 4.7 also shows that income level had positive association with transportation mode choice. Passengers their income, less than 2000 birr per month relative to income greater than 6000 birr per month were 2.051 times more likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model.

Similarly, passengers their income 2000-4000 birr per month relative to income level greater than 6000 birr were 8.102 times more likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model. Moreover, passengers their income level 4001-6000 birr per month relative to income level greater than 6000 birr were 8.151 times more likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model.

According to result Table 4.7, we observed that the logistic model showed that the likelihood of choice mode of transportation were Minibus taxi had significantly associated with transport factors (p-value < 0.05). Passengers transport factors of choice were comfortable relative to said less travel time were 3.299 times more likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model. Similarly, passengers transport factors to choose modes were considered fare relative to said less travel time were 0.219 times less likely preferring Minibus taxi relative to Anbessa City bus controlling for other variables in the model.

According to the result presented in Table 4.7, we observed the following Coefficients of independent variables,

$$Since, logit(p) = log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_k X_k$$

$$\text{Therfore, Minibus taxi relative to Anbessa City bus users} = 1.089 + 1.078[\text{Sex} = 1] + 1.067[\text{Income} = 1] + 2.092[\text{Income} = 2] + 2.100[\text{Income} = 3] + 1.194[\text{Transport factor} = 1] - 1.519[\text{Transport factor} = 2]$$

B) Light Rail Transit Users Relative to Anbessa City Bus

The multinomial logit estimate for choice modes of transportation were Light Rail transit relative to Anbessa City bus when the predictor variables in the model are evaluated at zero. For passengers who are male on the sex category evaluated at zero with the first three categories of the income levels and the first two categories of transport factors to choice evaluating at zero the logit for preferring Light Rail transit relative to Anbessa City bus was 1.670.

The logistic model showed that the likelihood of choice mode of transportation were Light Rail transit had significantly associated with sex (p-value < 0.05). Male passengers relative to female on sex category were 4.795 times more likely preferring Light Rail transit relative to Anbessa City bus controlling for other variables in the model.

Table 4.7 also shows, income had positive association with transportation modes choice. Passengers their income, less than 2000 birr per month relative to income greater than 6000 birr per month were 6.493 times more likely preferring Light Rail transit relative to Anbessa City bus controlling for other variables in the model. Similarly, passengers their income level, 2000-4000 birr per month relative to income level greater than 6000 birr

per month were 2.520 times more likely preferring Light Rail transit relative to Anbessa City bus controlling for other variables in the model.

According to result Table 4.7, we observed that the logistic model showed that the likelihood of choice mode of transportation were Light Rail transit had significantly associated with transport factors to choose mode of transportation. Passengers on transport factors category said comfort relative to said less travel time were 0.265 times less likely preferring Light Rail transit relative to Anbessa City bus controlling for other variables in the model. Similarly, passengers from transport factors category were said less fare relative to said less travel time were 8.068 times more likely preferring Light Rail transit relative to Anbessa City bus.

According to the result presented in Table 4.7, we observed the following Coefficients of independent variables,

$$Since, logit(p) = log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_k X_k$$

$$\text{Therfore, Light Rail transit relative to Anbessa City bus users} = 1.670 + 1.568[\text{Sex} = 1] + 1.871[\text{Income} = 1] + 1.655[\text{Income} = 2] - 0.294[\text{Income} = 3] - 1.327[\text{Transport factor} = 1] + 2.088[\text{Transport factor} = 2]$$

.

Table 4.7: Estimated Multinomial Logistic Regression Coefficient Results

Mode of transportation choice		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Minibus taxis	Intercept	1.089	.297	13.436	1	.000			
	[Sex=1]	1.078	.429	6.313	1	.012	2.939	1.268	6.816
	[Income=1]	1.067	.202	27.901	1	.000	2.051	5.458	12.028
	[Income=2]	2.092	.362	33.397	1	.047	8.102	1.008	4.171
	[Income=3]	2.100	.388	29.294	1	.036	8.151	1.057	4.828
	[Transport factor =1]	1.194	.326	13.393	1	.000	3.299	1.741	6.252
	[Transport factor =2]	-1.519	.186	66.694	1	.000	.219	.152	.315
Light Rail transit	Intercept	1.670	.178	88.022	1	.000			
	[Sex=1]	1.568	.311	25.420	1	.000	4.795	2.606	8.824
	[Income=1]	1.871	.923	4.109	1	.043	6.493	1.063	39.665
	[Income=2]	1.655	.134	152.541	1	.000	2.520	.400	.676
	[Income=3]	-.294	.450	.427	1	.513	.745	.309	1.798
	[Transport factor =1]	-1.327	.208	40.647	1	.000	.265	.176	.399
	[Transport factor =2]	2.088	.333	39.261	1	.000	8.068	4.199	15.504

a. The reference category is:Anbessa City bus

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study presents assessment on passengers' choice of transportation modes by considering the three public transportation modes; Minibus taxi, Anbessa City bus and the new Light Rail transit in Addis Ababa. A descriptive analysis was adopted in order to describe and summarize the socio economic as well as transport related factors and an inferential analysis was used in order to reach a conclusion about population on the information contained in the sample drawn from the population.

According to the result, (28.97%) of the passengers choice was Minibus taxi, (43.45%) of them choice was Light rail transit and the remaining (27.58%) of the passengers' choice was Anbessa City bus. From this, majority of the passengers choice was Light Rail transit.

The analysis result showed that from the identified socio economic factors sex and income have significant association with mode choice have a value of (X^2=6.87, df=2 and p=0.032) and (X^2=420.50, df=6 and p=0.001) respectively, and transport related factors as (X^2=695.00, df=4, and p=0.000).

According to the result, the Nagelkerke R^2 was (98.8%) indicated that the explanatory variables were useful in providing mode of transportation choice model using a multinomial logit model.

Finally, the multinomial logit analysis result showed that, the socio economic as well as transport related factor had positive and negative association with transport mode choice.

According to the result, the model shows the following coefficients of independent variables:

$$\text{For Minibus taxi users relative to Anbessa City bus users} = 1.089 + 1.078[\text{Sex} = 1] + 1.067[\text{Income} = 1] + 2.092[\text{Income} = 2] + 2.100[\text{Income} = 3] + 1.194[\text{Transport factor} = 1] - 1.519[\text{Transport factor} = 2]$$

$$\text{Similarly, for Light rail users relative to Anbessa City bus users} = 1.670 + 1.568[\text{Sex} = 1] + 1.871[\text{Income} = 1] + 1.655[\text{Income} = 2] - 0.294[\text{Income} = 3] - 1.327[\text{Transport factor} = 1] + 2.088[\text{Transport factor} = 2]$$

5.2 Recommendations

Based on the results of the study, the following recommendations have to be taken in to considerations.

- Obviously, it is impossible to solve Addis Ababa transport problem by using only small-scale transportations, and the government must focus on mass transportation. According to the result, passengers were highly dependent on mass transportation but its transport related factors (comfort, travel time and fare) were didn't satisfy the travelers. Therefore, there should be a re-organized and well arranged mass transport services in the city.
- Light Rail transit users were more than Bus as well as Taxi transport users for men and Minibus was dominantly used by women. However, the dependency on public transport services was higher in males (60.4%) than in the females (39.6%). Therefore, in order to maximize the public transport users and initiate female travelers, there should be a special considerations given for females to create a

safe and comfortable transport service while using public transport. This, can be do like by give a way for them while they use public transport.

- Accessibility to the public transport has an important role to play good as well as efficient mobility to the passengers. This is determined by the routes and the location, the stop and their coverage. The Addis Ababa Light Rail Transit on phase-1 covers only the East -West stretching from Ayat to Torhayloche and the North-South line, stretching from Kality to Menelik Square and thus, at this stage, only limited population had the access to it. The result indicates, a majority of passengers were using this LRT so that there should be a necessity for more routes and proper location stop points to have more coverage. So, other remaining phases of the LRT, to be implemented in the future, are expected to increase the coverage to most of the city areas, which will helps to reduce transport problem in the future.
- Introducing a new Bus Rapid Transit (BRT) system:

  Majority of the less income groups in Addis Ababa selected Anbessa bus transport system as a major modes of transportation. Therefore, the government should provide the BRT having high quality with an aim to provide faster, more comfortable and cost effective service.

5.2.1 Further Researches

This thesis has only explored a small territory in using statistical analysis approach. There are many possible directions for future work, which include the following:

- ✓ **Finding other factors that influence the choice of mode**

  In this study, only three transport related factors have been quantified. There are most probably other transport related factors that would also be useful to quantify

and put into a forecast model. The quantified factors in this study should also be quantified together with the socio-economic parameters of peoples in order to obtain a more balanced view of people's willingness to pay for the transport related factors.

- ✓ **Finding other modes that influence passengers' choice**

  This thesis is only includes public transport systems such as; Anbessa city bus, Minibus taxi and Light rail transit. In the future work, other transport service can be included.

- ✓ **Knowledge haw different individuals are influenced due to the locations**

  Research is needed on haw the locations of homes, business centers and work place affect our choice of travel modes. Hence, overall planning is important to achieve a holistic view, for instance a study of haw model split in the area is affected when a new business sets up or a new homes built should perhaps be a requirement.

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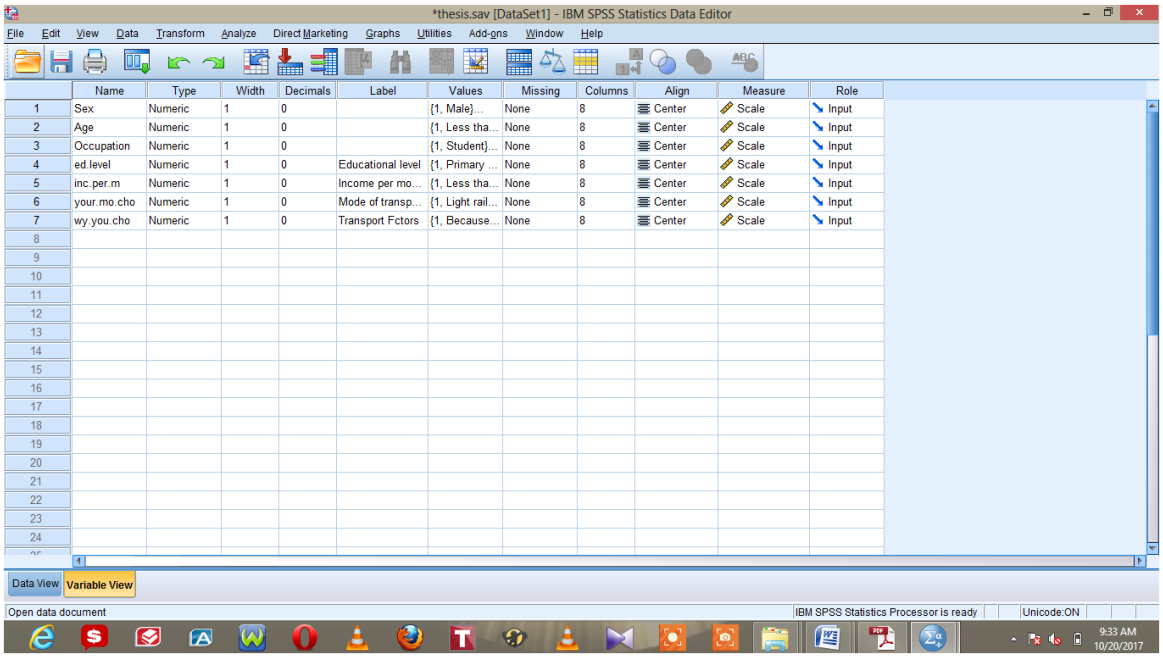
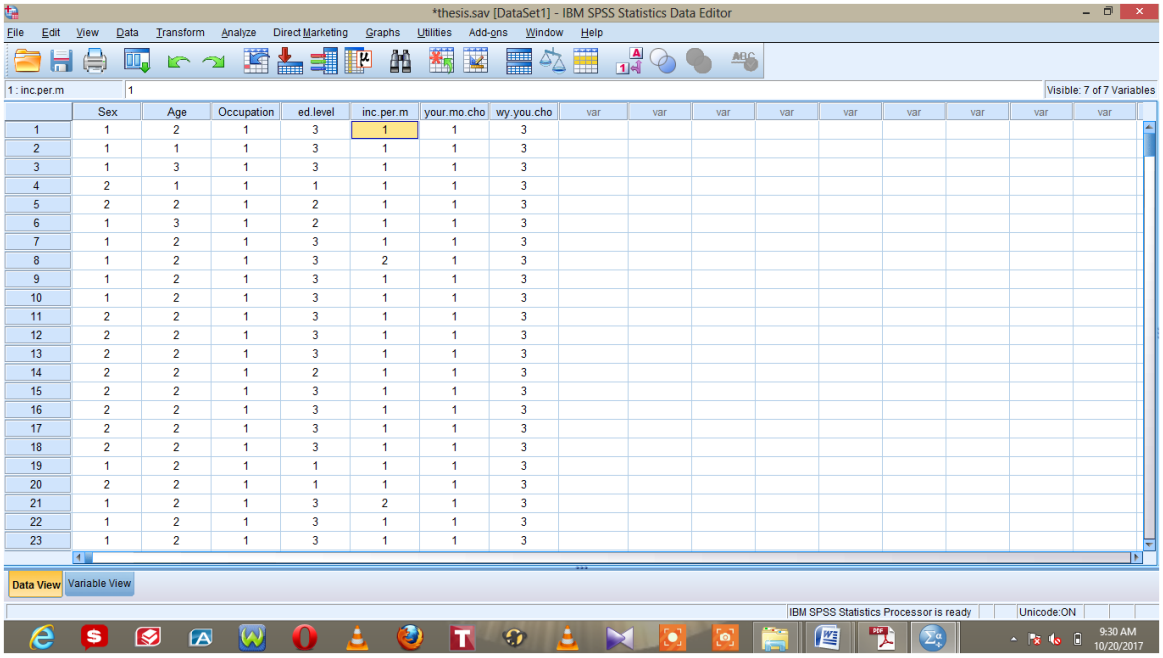
APPENDIX

Appendix-A: SPSS names, labels, values and measures used during analysis

Appendix-A1: Variable View



Appendix-A2: Data View



Appendix- B: Z-Value

Confidence level (%)	Z- values
99	2.576
95	1.960
90	1.645
80	1.282
60	0.842
50	0.674

Source: (Singh, et al., 2014)

Appendix- C: Frequencies

```
GET
  FILE='C:\Users\pc\Desktop\potos\thesis.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
FREQUENCIES VARIABLES=Sex Age Occupation m.status ed.level fa.size fa.mo.cho inc.per.m
your.mo.cho wy.you.cho
  /STATISTICS=RANGE MINIMUM MAXIMUM STDDEV MEAN MEDIAN
  /FORMAT=LIMIT(50)
  /ORDER=ANALYSIS.
```

Frequencies

[DataSet1] C:\Users\pc\Desktop\potos\thesis.sav

Frequency Table

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	217	60.4	60.4	60.4
	Female	142	39.6	39.6	100.0
	Total	359	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 18 years	16	4.5	4.5	4.5
	18-25 years	138	38.4	38.4	42.9
	26-50 years	125	34.8	34.8	77.7
	> 50 years	80	22.3	22.3	100.0
	Total	359	100.0	100.0	

Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Student	155	43.2	43.2	43.2
	Employee	204	56.8	56.8	100.0
	Total	359	100.0	100.0	

Educational level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	54	15.0	15.0	15.0
	Secondary	71	19.8	19.8	34.8
	Above secondary	234	65.2	65.2	100.0
	Total	359	100.0	100.0	

Income per month

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 2000 birr	103	28.7	28.7	28.7
	2000 - 4000 birr	112	31.2	31.2	59.9
	4001-6000 birr	121	33.7	33.7	93.6
	>6000 birr	23	6.4	6.4	100.0
	Total	359	100.0	100.0	

Transport Factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Because it has less fare	101	28.1	28.1	28.1
	It is comfortable	104	29.0	29.0	57.1
	It has less travel time	154	42.9	42.9	100.0
	Total	359	100.0	100.0	

Appendix-D: Questionnaires

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

HIGHWAY ENGINEERING STREAM

Dear respondents:

This questionnaire is designed to gather data on Assessment on passengers' choice of transportation modes (Light rail transit, Anbessa city bus, and Minibus taxis) in Addis Ababa a case study at "Torehayloche - Mexico " Route. In order to achieve this purpose and to investigate the case deeply, your response to the questions given below have a crucial value. Therefore, you are kindly requested to read the questions carefully and give accurate and real data which exists on the ground. The response that you reply will not be used for any other purpose other than this research work. So please be free and give your honest and genuine response.

Thank you in advance for your Cooperation!

Instruction: Circle the letter of your choice for the following questions. You may respond more than one answer if it is necessary.

1. Sex 1. Male 2.Female
2. Age 1.<18 2. 18 - 25 3.26 – 50 4.>50
3. Occupation

   1.Student 2. Employee 3. Other
4. Educational level

   1.Primary education

   2.Secondary Education

   3.Above Secondary Education
5. Income per month

1.Less than 2000 birr 2.2000 – 4000 birr

3. 4001-6000birr 4.More than 6000birr

6. Which transport mode do you usually use?

1.Light rail transit 2. Anbessa city bus 3. Minibus taxis 4.other

7. Why you do you need to choose the above mode of transportation?

1.Because it has less cost 3. It has less travel time

2.Because it is comfortable

ጅማ ዩኒቨርስቲ

የ ሲቪልና የአካባቢ ምህንድስና ትምህርት ክፍል

እኔ በ ጅማ ዩኒቨርስቲ የምማር ተማሪ ስሆን በአዲስ አበባ በተለይም ከጦርሀይሎች እስከ ሜክሲኮ የተሳፋሪዎች ትራንስፖርት ምርጫ በሚል ሀሳብ ዙሪያ ጥናት የማደርግ ተማሪ ነኝ፡፡ ለዚሁም የምትሰጡት መልስ ለጥናቱ ውጤታማነት ከፍተኛ አስተዋፅኦ ያለው መሆኑን አስገነዝባለው፡፡ ስለዚህም መጠይቁን ሙሉ በሙሉ በተቻለ መጠን በቅንነትን በመልካም ፍቃደኝነት መመለሳችሁ የጥናቱን አላማ ለማሳካት እንዲያስችለኝ ይረዳኛል፡፡ እዚህ ላይ የተመለከቱት መረጃዎች ለትምህርታዊ ጉዳይና አላማ ብቻ የሚውለ በመሆናቸው በከፍተኛ ታማኒነት መልሳችሁን እንዲትሰጠኝ እጠይቃለሁ፡፡ የመላሾች ሚስጥራዊነት የተጠበቀ ነው፡፡ በመሆኑም ሰም መፃፍ አያስፈልግም፡፡ የሚከተለትን ጥያቄዎች በተሰጠው ሳጥን ምልክት በማድረግ እንዲሞሉት በትህትና እንጠይቃለን፡፡

1.ጾታ፡ - 1.ወንድ ☐ ሴት ☐

2. እድሜ፡ - 1. ከ 18 አመት በታች ☐ 2. 18-25 አመት ☐

3. 26-50 አመት ☐ 4. ከ 50 አመት በላይ ☐

3. ስራ፡ - 1.ተማሪ ☐ 2.ሰራተኛ ☐

3. ሌላ ☐

4. የትምህርት ደረጃ፡ -

1.አንደኛ ደረጃ ☐ 2.ሁለተኛ ደረጃ ☐

3. ከሁለተኛ ደረጃ በላይ ☐

5. ደሞዝ (አማካኝ) 1. <2000ብር ☐ 2.2000-4000ብር ☐ 4001-6000 ብር ☐

4. >6000ብር ☐

6. የሚጠቀሙት የትራንስፖራት አይነት፡ 1. በ ባቡር ☐ 2. ባስ ☐

3. ሚኒ ባስ ታክሲ ☐ ☐

7. ይህንን የትራንስፖራት ዓይነት ለ ምንድነ ዉ የመረጡት

1. አነስተኛ ክፊያ ስለሚያስከፍል ☐ 2.ምቹ ስለሆነ ☐

3. ፈጣን ስለሆነ ☐

Appendix- E: Transport Related Tables

Distribution of Buses, trips and routes on each Terminals

No.	Terminal	No. of Routes operated	No. of Buses operated
1	Legehar	21	112
2	Mercato	39	156
3	Menilik square	13	64
4	Megenagna	13	53
5	Minor Terminals	33	131
Total		119	516

Source: (Addis Ababa city enterprise, 2005)

Types of vehacle and thir seating capacity

No.	Types of vehacles	Total No. of vehacles	Seat capacity
1	Minibus taxi	1200	12
2	Anbessa city bus	1073	100
3	Higer mibibus	593	27
4	Star Aliance bus	70	45
5	Public buses	301	45
	Shager bus	132	45
6	Saloon taxi	4,300	5
7	Supported white minbus	4,325	12
8	Supported cross - country buses	510	75
9	Private vehacles	227,751	-
10	Trucks	218,275	-
11	Passengers buse entering the city everyday	6,357	-

Source: Addis Ababa Transport Autority, 2005

Number of minibus taxi in Addis Ababa in 2008

	Addis Ababa sub city	Total No. of taxi routes	Total No. of taxi planed	Total No. of taxi properly working on the route	Total No. of taxi for student service	Total No. of taxi absence on the route
1	Akaki - Kality	18	606	447	70	89
2	Nefas Silk - Lafto	33	1336	1101	231	290
3	Kolfe Keraniyo	44	523	637	211	-
4	Gulele	27	949	900	82	-
5	Lideta	34	404	420	201	-
6	Kirkos	33	811	651	-	-
7	Arada	59	998	557	-	-
8	Addis Ketema	22	637	782	78	-
9	Yeka	55	1458	1472	165	-
10	Bole	39	1087	1001	110	-
Total		364	8,809	7,963	1148	379