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Private vehicle owners' willingness to pay for outdoor clean air in Addis Ababa

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PRIVATE VEHICLE OWNERS' WILLINGNESS TO PAY FOR OUT DOOR CLEAN AIR IN ADDIS ABABA

Certification

I, the undersigned, certify that I read and hear by recommend for acceptance by Addis Ababa University a thesis entitled "***Private vehicle owners' willingness to pay for outdoor clean air in Addis Ababa"*** in partial fulfillment of the requirement for the Master of Arts in Environment and Sustainable Development.

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Miftah Musbah Mohammed, declare that this thesis is my own original work that has not been presented and will not be presented by me to any other University for similar or any other Masters Award.

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Abbreviations and Acronyms

CAD	Canadian Dollar
CNY	Chinese Yuan
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
CRGE	Climate Resilient Green Economy
CO	Carbon Monoxide
CSA	Central Statistical Agency
CV	Contingent Valuation
CVM	Contingent Valuation Method
EIA	Environmental Impact Assessment
EPA	Environment Protection Authority
ETB	Ethiopian Birr
FY	Fiscal Year
GHG	Green House Gas
GTP	Growth and Transformation Plan
HH	Household
INAA	Instrumental Neutron Activation Analysis
ITCM	Individual Travel Cost Model
MLR	Multiple linear regression
MoH	Ministry of Health
NPC	National Planning Commission
NBE	National Bank of Ethiopia
NO	Nitrous Oxide
PM	Particulate Matter
TCM	Travel Cost Model
TPB	Theory of Planned Behavior

USA	United States of America
USD	United States Dollar
UNEP	United Nations Environmental Program
WHO	World Health Organization
WMO	World Meteorological Organization
WVS	World Value Service
WTA	Willing to Accept
WTP	Willing to Pay
SLCP	Short Lived Climate Pollutants
SPSS	Statistical Package for Social Sciences
ZTCM	Zonal Travel Cost Model

ABSTRACT

Vehicular transport is one of the major sources of air pollution in the transport sector. Vehicular emission results in to the death of millions of premature deaths. The ambient air pollution induced by the transport sector causes a serious health problems, recent evidences focusing on respiratory and cardiovascular effects were associated with exposure to short term or long term exposure to air pollution. To this effect, this study is mainly intended to determine WTP of private vehicle owners' that have a contribution to the problems. Furthermore, it elaborates the amount there are willing to pay to induce a dedicated fund in mitigating the problem to improve the quality of air and make livable. The research has adopted a stated preference method where the value of use and nonuse of natural goods is determined through CVM. Thus, an open ended pretest survey was conducted to determine the initial bid. Then, the final survey has adopted a closed ended questionnaire type. The analysis part was adopted to use a probit and Tobit regression model. Subsequently, the result shows that level of education has positive sign significant effect, while respondents number of years lived in Addis Ababa and vehicle service year have negative sign and significant effect. The research was able to draw Mean Willingness to Pay (MWTP) which has a value of 17.10 ETB per month and the aggregate WTP has a value of 2,874,294.5 ETB per year. To this end, this study can serve as an indicator to the planners and policy makers' effort taken to cut vehicular emission. The study reveal that private vehicle owners were willing to participate in any action taken to reduce the ambient air pollution emerges from their car. This study tried to promote the implementation and efficiency of the existing pollution regulation. If the liability with regard to air pollution comes to a single private vehicle owners, and policies are derived on the subject, this study can serve as an indicator and the milestones raised on this study can be taken in to account for further studies. Finally, this research reveal private vehicle owners were interested to support both the presented air pollution reduction principles and financial contribution in widening public engagement in the prevention process.

Keywords: Contingent valuation, Willingness to pay, Property rights.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Background of the study

Environmental resources provide a flow of direct and indirect limitless services to a society. Nonetheless many of these services remain unpriced by the market (Nick, 1997). This resource is now endangered and found under intense pressure due to natural and anthropogenic effects. Accordingly, air pollution is one of a serious threats to environment as well as human health. World Health Organization in 2012 studied that out of every nine deaths was the result of air pollution related conditions. Particularly, around 3 million are attributable solely to ambient (Outdoor) air pollution (WHO, 2016). Furthermore, the report released by WHO (2016), states that, among the world population more than 11% of deaths were related to air pollution. As it was further justified in 2017, more than 25% of greater than 5 years age children deaths are associated with air quality problem.

Vehicular transport is the dominant mode of transportation system in Ethiopia where 75% of the emissions come from this sector, particularly freight and construction vehicles are the major contributor while passenger vehicles have minimal effect (CRGE, 2012). Likewise, air transport has a 23% share on transport related emissions.

In a great stride of combating the problem, the Council of Ministers introduced Proclamation No. 300/2002 for environmental pollution control. The Proclamation explicitly states that no person shall pollute the environment by violating the relevant environmental standard, a person who contravenes and causes any pollution shall be required either to clean up or pay the cost of cleaning up the polluted environment within the time determined by the Authority. Furthermore, GTP II has been trying to mitigate environmental pollutions which arose from urban expansion, change in life style and industrial growth, appropriate systems and measures will be established (NPC, 2016). Efforts has aligned with the implementation of climate resilient green economy (CRGE) at all levels.

In spite of all the above efforts, studies show that air pollution in Addis Ababa is persistently increasing through time. Usually economic and population growth will significantly affect the quality of air to a risk level, where it is becoming a threat for healthy living conditions. Many health-harmful and dangerous air pollutants are being emitted from different economic activities such as vehicular operation (Yohannis, 2018). There are two major probable driving factors for the vehicular population rise in Ethiopia. Economic and

population growth: Ethiopia is one of the fastest growing economies in East Africa registering 7.7 percent growth in 2018 (NBE, 2018) which stimulates high transportation demand. The other population growth where Ethiopia is the second most populous country in Africa. By the year 2017 the total population size was estimated to be 104.96 Million, and by 2030 the projected total population size will be expected to reach 139.62 Million having annual growth rate of 2 % (CSA, 2013). In addition, this has a tendency to increase waste accumulation in our environment. Moreover, According to the report presented by Ethiopian police commission bureau, to satisfy the entire transportation demand induced by both the economic and population growth the total number of vehicle fleets operating in Addis Ababa has significantly increased and attain a total vehicular fleet number of 553,938 (59.2%) out of the total national figure of 935,888 in 2018.

In connection to the number of vehicular fleet increment, emission from transport sector would grow from around 5Mt $C0_2e$ in 2010 to 40 Mt $C0_2e$ in 2030 (CRGE, 2012). Consequently, the condition will worsen an adverse health effect in the study area. In view of this, the available evidence by Ministry of Health (2003), entails that, 1,262,908 (5%) cases of acute upper respiratory infections and a 5 % of Pneumonia cases (this accounts for 7 % of hospital admissions) that might be linked to air pollution occurred in 2010/2011. Moreover, 2 % of hospital admissions in the same year was due to Tuberculosis (Ministry of Health, 2003), put roughly, air pollution could be the cause of these hospital admissions. Another study carried out by Misganaw (2012), tuberculosis and respiratory infections as the second (11%) and third (8 %) causes of the deaths that occurred in public and private hospitals in Addis Ababa for the study period 2006-2009. This roughly equals to the deaths caused by HIV/AIDS (11%).

Similarly, air pollution from vehicle tail pipe exhaust has a negative impact on plant growth, mainly it affects the photosynthetic pigments respiratory activities, enzymatic activities and water uptake (Mohammed, 2015).

Air pollution in Addis Ababa have a tendency to increase due to the rise of anthropogenic activities, similarly, the health effects discussed above may simultaneously increase. To this effect, this study is limited to private vehicle owners, where the number of vehicles has been significantly increasing through time. So, this study investigates the willingness of private vehicle owners in tackling the problem. Meanwhile, it gives confidence to planners and policy makers to device a solution as a result of feedback obtained from the study showing

a great interest of key contributors (private vehicle owners) in combating the ambient vehicular emission.

1.2. Statement of the problem

Air pollution can result from anthropogenic effects such as from construction industries, vehicle exhaust gases from transport sector, currently in cities there is a tendency to increase in consumption of fossil fuel, expansion of industries, stone quarries etc. Likewise there are natural causes for air pollution such as volcanic eruption, forest fire etc... (Mohammed, 2015). In the context of our country, Ethiopia is categorized as least industrial complex country. Whereas, CRGE (2012) describes that among the anthropogenic pollution causes, emission from vehicular transportation is the major sources for air pollution in Addis Ababa. Currently, air pollution level in Addis Ababa is presumed to be high due to the emissions caused by old vehicles, industrial activities, dust from traffic road that arises from poorly and slowly constructed road infrastructure induced by fast urbanization and the type and quality of high sulfur containing fuel usage are the major drivers of Addis Ababa air quality degradation (Yohannis, 2018). The mass concentrations of total suspended particulate matter in the city were beyond the WHO safe guideline value (Gebre, 2010). As it was referred by the study of Gebre (2010), the concentration of $PM_{2.5}$, P_{10}, SO_2, NO_2, O_3, CO and P_6 are 280µg/m^3, 20µg/m^3, 97 PPM, <45 PPb, < 0.1, and 2.8 PPM respectively, which are quite greater than the tolerable limit of WHO air quality guideline.

As a result of the above fact, several people are subjected to health problems that have been linked with illness and deaths from heart or lung diseases. The study carried out by (Yohannis, 2018) has explained that, due to the prevailing particle pollution problems, acute respiratory infection increased with annual growth rate of 47.18% from incidents 4539 in 2003 to 212,590 in 2017. The chronic Obstructive Pulmonary disease (COPD) and Pneumonia are being increased by annual growth rate about 53.44% and 24.89 % respectively. Also there are several other or unspecified diseases of the respiratory system that are currently being recorded at healthcare centers. Moreover, air pollution has tremendous effect on plants found near by the road (exhaust pipe), it is recognized to change he level of Chlorophyll for a certain species that ultimately reduce the plant branch length and yield for a certain species (Iqbal, 2015).

In order to address the problem, several studies were done regarding air pollution in Addis Ababa, among them: The study carried out by Abera (2010), entails the magnitude and variation of daily traffic air samples taken on road and road side during wet and dry season. In addition, Hailu (2013) tried to measure traffic air pollution in Addis Ababa city around selected bus stations using Instrumental Neutron Activation Analysis (INAA). Furthermore,

the available evidence by Wolde (2016) shows the relationship between cause of air pollution in Addis Ababa city related with urbanization, increment of motor vehicle population and transport system in the city. Again Worku (2016) argues that the average concentration of PM2.5 reached as high as an indoor carbon monoxide (Co) and tried to address the severity of air pollution. Thus, the above studies indicate the existence of air pollution in Addis Ababa and its adverse effects on residents' health, where the situation has observed to persistently rise through time. So, this study necessitated to investigate the WTP of private vehicle owners who are the key attributors of the problem, and testing their interest for the implementation of emission reduction policies beside to their interest of financial contribution.

In taking a pragmatic step to curb the hazardous effect of air pollution in Addis Ababa, this research recognizes the existence of air pollution and its adverse effect supported with document evidences. it reveals failure to practical application of policy instrument, again It will manifest the possible dominant sources of outdoor air pollution and determine private vehicle owners' willingness to pay from their monthly income through taxes to induce a dedicated fund to finance Environmental Protection Authority of Addis Ababa and ensure the statutory emission limit i.e. supposed to cut the current vehicular emission by 30%. Further, it tries to bridge the gaps of indicating private vehicle owners' to adopt technology based emission reduction techniques for the prevailing air pollution which are overlooked/ not addressed by many other researchers.

1.3. Objectives of the study

1.3.1. General objectives

To investigate private vehicle owners' willingness to pay from their monthly income via tax to Addis Ababa Environmental Protection Authority to cut vehicular emission in the city by 30% and examine factors affecting it.

1.3.2. Specific objectives

- To assess the perception of private vehicle owners towards vehicular air pollution problem in Addis Ababa and consider its health impacts;
- To estimate the amount of WTP of private vehicle owners from their monthly income via taxes for clean air service/ to cut air pollution by 30%;
- To examine determinants of private vehicle owners' WTP for reducing air pollution in Addis Ababa; and
- To assess private vehicle owners' attitude towards government effort in curbing the problem.

1.4. Research questions

To this end the research will attempt to answer the following questions in the study area:

In relation to the General objective:

- Are private vehicle owners willing to pay for any measures to be taken to curb the persistently increasing vehicular emission in Addis Ababa?

In relation to the Specific objectives:

- What is the perception of private vehicle owners in reducing vehicular air pollution and its consequential effect?
- How much will private vehicle owners are willing to pay from their monthly income through tax to cut vehicular emission by 30% in Addis Ababa?
- What are the key determinants of private vehicle owners' willingness to pay for reducing air pollution in Addis Ababa?
- What is the attitude of private vehicle owners towards government effort in minimizing the problem?

1.5. Scope of the research

Following the review of similar studies, this research recognizes the existence of air pollution and its adverse impact on the particular study area. To this effect, the study focuses on private vehicle owners found in Gullele sub city by adopting different emission reduction mechanism, and it determines how much they are willing to pay from their monthly income to Environmental Protection Authority of Addis Ababa to induce a dedicated fund via a means of tax to cut vehicular emission by 30%. .

Unfortunately, measuring air pollution in Addis Ababa is difficult and unachievable, to this fact, the research has no intention/ interest to study the magnitude, and severity of air pollution on spatial distribution basis; hence, the study is mainly focused on the following aspects:

- Thoroughly review literatures written about air pollution in Addis Ababa.
- Distribute the questionnaire for pre-survey test to determine the initial bid amount paid from their monthly income through tax for emission reduction using technology based policy instrument.

- Collect final data from private vehicle owners through the prepared questionnaire to determine the exact amount of willing to pay by private vehicle owners for clean air service in Addis Ababa.
- Examine key determinants of WTP for a reduced air pollution in Addis Ababa.

1.6. Significance of the study

In accord of sustainable development agenda, countries are committed to integrate triple values that need for thorough balance between economic growth, social aspect and environmental preservation. However, due to economic activities it is common phenomenon to observe industrial and transportation expansion are failing to meet environmental standards that keep the balance. To this effect, increase in emission of air pollutants upon pure public goods due to economic activities occur because of lack of property rights. This study attempts to present private vehicle owners' preference to pay from their monthly income through tax to combat air pollution in Addis Ababa. Accordingly, the research will hopefully have its own contribution in:

- Assessing the awareness of private vehicle owners in Addis Ababa about air pollution problems and their preferences to pay for mitigating the problem;
- Helps to tackle the resulting health effect caused by vehicular pollution;
- Broaden the awareness of policy instruments for future implementation;
- Studying to serve as a tipping point in drawing policy makers' attention for strategic change in the way that development has an impact on environment and urges to device a means to harmonize developmental activities with environmental preservation measures.

1.7. Organization of the study

The study comprises of five chapters. Chapter one gives a brief general introduction about the study: the background of the study, the statement of the problem, objectives of the study, research questions, scope and significance of the study. Chapter two deals about review of similar studies, regulations and policies to gain better understanding of the study area. Chapter three deals with Research Design and methodology, while Chapter four has data analysis, result and discussion. Finally, Chapter five presents summary of major findings, Conclusions, recommendations and suggestions for future research. Furthermore, the study enclosed list of keywords, acronyms, list of tables and figures, references and annexes.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Introduction

Literature review on various topics relevant to the study was conducted. It included researching willingness to pay for clean air in various parts of the continent. A literature review of similar studies, Regulations, and policies were conducted to gain a better understanding of the aspects involved regarding willingness to pay for pollution reduction, and identify any gaps. In addition, this study required a review of the adverse effects of air pollution on human health.

2.2. Willingness to pay for improved environmental amenities

Willingness to pay questions ask people to speculate on how much they would be willing to pay for something (Whitehead, 2006). Further it is elaborated as a technique used to predict individual's preference in tackling the problem through public participation and payments made via taxes, WTP literally en tails the preference of an individual/households in lessening the growing problem of environmental shortfall without being worse off than in the initial situation. The maximum amount of willingness to pay is dependent upon the available independent variable particularly on individual's income. In the course of considering payment for environmental preservation activities, there are various payment processing methods known as payment vehicle techniques. Tax is one of the payment processing methods. Although many people have resentment to accept payments associated with tax. Rather people can show their preference of showing willingness to pay through utility bills.

In the extraordinary level of smog pollution in urban areas of Beijing drives public demand towards a clean air. To this effect, the study conducted by Kangyin (2017) investigates the values of willingness to pay (WTP) for the smog mitigation in the above referred location. The study has adopted face to face interviews in addition to CVM as some questions in the CV survey are professional and needs oral explanation. The method implements interval regression model to analyze the determinants of public WTP for the mitigation of environmental shortfall. The study considers the socio-economic and socio-demographic independent variables that have an effect on the dependent variable (WTP). The independent variables are Gender, age, education, health condition and annual income. Carrying out the analysis, the result of the study carried out by Kangyin (2017) has shown that more than 80% were willing to pay for the mitigation measure. Hence respondents are WTP rises with the increasing smog mitigation percentage of 30%, 45% and 60% amounting 615.13 CNY,

716.34 CNY and 914.49 CNY respectively. These accounts for 0.55%, 0.64% and 0.82% of their annual income. Yet again Thomas (2017) studied the willingness to pay for a reduction of air pollution emitted from vehicle tail exhaust pipe in Quebec and France. The researcher adopted a contingent valuation method coupled with a probit model to determine the average WTP. The research contains some independent variables that affect the ultimate output of WTP. Namely: Age of the respondent, the household gross income, the number of years of education, the reduction in the cars pollution emission and a geographic variable indicating where the respondent is reside. Other variables such as gender, number of vehicle owned and service year of the vehicle fleet do not appear to be statistically significant in the study. Finally the study concluded that in 2009 the average maximum WTP for cleaner vehicles of approximately 5440 Canadian Dollars for a 62.2% reduction in car exhaust gases.

The spatial expansion of settlement in urban area stimulates economic activities which will contribute to climate change. The majority of source of energy for economic activities comes from traditional sources (Tiruwork, 2017). To this fact, the research produced by Tiruwork (2017), investigates household willingness to pay for green electricity services and welfare gains. A double bound CVM is implemented upon 300 HH samples in urban and pre-urban areas of northern Ethiopia. Bivariate probit model was used for determining the factors that affect households' WTP and estimate mean WTP for the expansion of electricity generated from green energy sources. The household willingness to pay for green electricity energy was influenced by, Age, Gender, access to green energy information, marital status, initial bid, income, distance from home to the nearest wood and charcoal market and being a tax payer. The paper again briefed that older house heads more willing to pay for expansion of green electricity than young house heads. In order to avoid initial bid bias, The HH average three years of electricity bill was taken to design the initial bid amount that vary between 10-15%.

The study performed by Tiruwork (2017), investigates the mean willingness to pay to be 12.5 ETB (0.66 USD) per month per household for five years on the top of the monthly electricity bill.

According to the current global condition where the power demand increases through time, renewable energy can be taken as a best energy source since it can reduce pollutant emissions and improve the quality of air. Many countries has engaged on green electricity in an effort to mitigate greenhouse gas emissions by maintaining the ongoing economic development. The study performed by Bai-Chen Xie (2018), testifies individual's preference for their WTP, for the available green electricity alternative in combating the emissions of greenhouse gas. The study applies CVM to investigate WTP in Tiajin, China. The researcher employs Logit regression and multiple linear regression (MLR) methods to analyze the collected data. Logit was used to make regression analysis on whether

responders had positive attitudes to green electricity development and determine what factors affected their attitudes. The Multiple linear regression was used to distinguish the factors that significantly affected the residents WTP. And the results of the two regressions were compared. The critical driving factors which have effect on WTP include income, belief, disease age and gender. The analysis showed that the average WTP among males CNY 32.2 per month was significantly higher than that of females CNY 27.14 per month. In a summarized way among 468 samples of respondents, most of them are willing to pay an average value of CYN 32.63 per month for the facilitation of an alternative renewable energy source in Tianjin, China (Bai-Chen Xie, 2018). A similar study conducted in Ontario, Canada using Contingent valuation method shows, for a 90% reduction in the pollution emission of a present day average car, they have calculated an additional WTP between 2034 and 4819 CAD depending upon household income (West, et al., 2013).

In USA the action taken to improve downstream environmental habitats and recreational area imposes pressure in altering operations of large hydro-electric dams. Alternatively, the use of electricity from fossil fuel base on power plants emit greenhouse gases (GHG) that escalate global climate change. The study estimates households' willingness to pay using contingent valuation method to preserve GHG reductions provided by the current Glen Canyon Dam operations. Results indicate that US households are willing to pay an additional $3.66 per year in increased Taxes to prevent increases in GHG emissions due to proposed-repurposing.

2.3. Environmental valuation methods

In a stride of measuring the benefits of natural goods that are not traded for improved environmental quality, the preference of the people will be measured for a good or bad environmental quality. Among the techniques of measuring the values of non-market goods, there exists two broad types of environmental valuation techniques, namely: the revealed and stated preference techniques.

2.3.1. Contingent valuation method

The aggregate effect of use and nonuse values of a good help to determine the Total Economic Values. Use values which are related to direct uses are measured by WTP, while non-use values like existence and bequest value measures consumers WTP to protect the environment (Quay, 2014). Evaluation of non-market natural goods implements revealed or stated preference techniques. Revealed preference methods depends upon the consumer purchasing habits to infer WTP for non-market good. Whereas stated preference methods enrolls asking individuals how much they value the use and non-use values of the good in discussion (Quay, 2014). In determining the value of natural goods that are not traded on markets such as but not limited to, land scape scenic, air, a CVM is a preferred method. In

CVM questionnaires will be developed to request respondents if they would be prepared to pay a fixed amount either for an improvement or avoid degradation in the quality or quantity of environmental goods (Coskeran, 1998). To this end contingent valuation method (CVM) is known to be the most widely applied approach for estimating non-market values of public goods (Carson, 2012). More importantly, the purpose of adopting the technique is to estimate individual willingness to pay for changes in the quantity or quality of goods or services since it offers great flexibility compared with behavioral methods (McConnell, 2002). The essential tasks carried out in CV analysis is the design of questionnaires and field survey procedures. A CV question asks a respondent about monetary valuation of a service. There exists two types of questions, namely: open ended and closed ended questions. As it was described by Whitehead (2006), the open ended questions asks respondents to state the amount they would be prepared to pay for a good. However, closed ended questions compel/constrain answers by specifying response categories. Both open ended and closed ended questions have their own merits and demerits. The advantages of open ended question is that you arrive at with a point estimate of the response. Contrarily the open ended question is relatively difficult to answer (Whitehead, 2006). He again explore that, a payment card is an alternative to open ended question, payment card questions asks open ended question but provides interval. The method preferred when if the survey budgets are constrained and you use small samples a payment card valuation is preferred over the open ended questions (Whitehead, 2006). A closed ended question (dichotomous choices) provides an initial bed level which is then followed up with higher or lower bids depending upon the respondents' original answer (Quay, 2014). This might give you a yes/no response, an interval response, an ordinal scale response. According to the discussions made above open ended questions have remarkable advantages, most of your questions should be closed ended due to the following facts stated by Thomas (2017), closed ended questions are much easier for respondents to answer, a respondent will answer without as much worry about what the answer is supposed to look like. A Closed-ended question was the iterative bidding question you could keep iterating up and down until the respondent's willingness to pay was narrowed down to the certain gap. Unfortunately, iterative bidding has a disadvantage of that it is prone to starting point bias (Thomas, 2017).

Furthermore, Whitehead (2006) argues that, the closed ended (dichotomous choice) question has been the dominant form of CV question and it is similar to the initial iterative bidding question with the following differences, the starting point is varied across survey respondents. The advantage of the dichotomous choice question is that each respondent is asked a single valuation question that is relatively easy to answer. The major disadvantage is that you, the CVM researcher, only learn whether each respondent's willingness to pay is above or below the dollar amount threshold. More sophisticated econometric methods are necessary to develop an average willingness to pay amount. Another disadvantage is that larger samples are necessary to implement the dichotomous choice approach.

Bearing in mind the above raised points, as a conclusion one of the purposes of asking questions is that to induce a response from respondents through a prepared direct questionnaire about monitory valuation to an environmentally improved services. The process involve through one of the most important steps of pre-testing, the aim of pre-testing is to fix the initial bid amount that are randomly assigned by respondents (Whitehead, 2006).

The second crucial determinants of CV question method is, vehicle for payment, it is a method that used to bridge payment with the required service. Various payment processing methods are depicted on (Whitehead, 2006). Among that, the common method is to link public goods services with Tax Payments. But other methods such as payment on utility bills can also be used. But in all cases we should capture the idea that whether the payment vehicle is realistic, believable and neutral.

2.3.2. Hedonic pricing

It is an implicit method of environmental valuation method. Hedonic pricing is technically used in the context of atmospheric pollution. Clean air is an important element that influence residential property prices (Roger, 2003). Moreover, Roger (2003) discussed that in a revealed preferences technique other things being equal, a positive relationship exists between the prices that people are willing to pay for housing and the quality of ambient air standards. Basically beside to air quality the following attributes influence housing rents: house size, amenities, proximity to employment and neighborhood characteristics and others.

In line with the finding of Resosudarmo (2009) willingness to pay for improved environmental quality in developing country is extremely low. Moreover, the research conducted by Richard (2019) identifies three problems in the estimation of marginal willingness to pay using hedonic pricing method. First, the implementation of conventional hedonic model first assumes that households are freely mobile across locations, but the costs associated with migration are high in developing countries. Second, the hedonic model assumes that household are free to select an amenity bundle from a continuous joint distribution of local attributes but the spatial distribution of amenities is discrete and may contain many holes (may highly imbalanced across locations). Third Air pollution is likely to be correlated with unobservable local variables that affect both housing costs and households' income.

In line with the study carried out by Richard (2019) in China tests, the willingness to pay for the reduction of particle air pollution of PM2.5 explain the initiation of air pollution in the city, the study adopts conventional hedonic model and it considers two instrumental variables for the analysis, accordingly wind direction and location of thermal power plants in the direction of up-wind can play significant role in the city. The research underlines that

in most developing countries, economic development, job opportunities, government provision of public services and polluting industries are the critical variables in the estimation of hedonic prices for environmental amenities. Similarly, in this research the main variables explaining the formation of WTP is the proposed bid price, Age, household income, educational status and geographic location. Other variables such as gender, number of vehicles owned and service year do not appear to be statistically significant. The research applies Probit regression model and the result entails that economic value of air quality improvement associated with a one unit decline in PM2.5 concentration is up to USD 8.83 billion for all Chinese household in 2005 (Richard, 2019).

2.3.3. Travel cost model

Travel cost method is an indirect approach found under revealed preference approach which enhances environmental valuation of non-marketable goods (Agahei, 2017). Basically it estimates the value of recreational benefits derived from ecosystems based on how far consumers would travel. It explicitly serve as an economic development tool induced from environmental improvement and economic performance of a region to attract visitors or economic labor growth can be evaluated (Agahei, 2017).

Natural resources like lakes, forests, landscape scenic are used extensively for the purpose of recreation. But, it is often difficult to value these resources since no prices will generally exist for these goods. Accordingly, TCM is an appropriate method for the analysis of same (Das, 2014). It is first been proposed by Hoteling that was first reported by Prewitt (1949) where he suggested the costs incurred by visitors could be used to develop a measure of the recreation value of site visited (Das, 2014). However, it was clawson (1959) and knetsch (1966) who first developed empirical models along these lines (Das, 2014).

The model assumes that travel and recreational amenity services of the park are being assumed to be weak complements, it is assumed that travel and access costs are behaviorally equivalent. The study of TCM is a survey technique where a questionnaire is often prepared and managed to a sample of visitors at a site in order to know their place of residence. In accordance with Das (2014) the TCM has three major dimensions to travel cost analysis of the demand for an environmental good. First is dimension concerns how demand depends on quality of the good, second is associated with the number of duration of trips during a period of time such as a year, third concerns the treatment of substitute such as when a visitor to a national park faces the choice of several parks.

Travel cost can be divided in to two basic categories. First the individual travel cost method (ITCM) which accounts for estimating individual's recreation demand functions. This is done by observing the visitation rate of individuals who make trips to a recreational facility as a function of the travel cost (Das, 2014). The zonal Travel cost method (ZTCM) was first applied and developed by Clawson at resources for the future in the late 1950s and 1960s (Das, 2014). While comparing the two methods, the following discrepancies will be observed. First, as per the study conducted by Garrod and Willis (1991) showed that the two methods are producing different results, Individual travel cost models are preferred over zonal travel cost model (Das, 2014). The zonal travel cost model is statistically inefficient since it aggregates data from a larger number of individual observations in to a few zonal observations. Moreover, all individual from within a zone are considered to have the same travel costs in the zonal model, second there are a number of methodological problems associated with the use of an average value as a dependent variable (Das, 2014).

Furthermore, while comparing TCM and CVM approaches, in the former method data are usually collected at the site for which benefits are being estimated. If a benefit estimate is needed for a site being planned, data must be gathered at a similar area. Difficulty is usually encountered when trying to find a similar area to use. Whereas, Contingent valuation requires personal interviews which are expensive to obtain. So, the CVM is flexible in estimation of benefits of an existing or proposed project (Das, 2014). The author again added that choice varies between choosing these two methods in regard to reliability of results. Researchers may argue on that the contingent valuation model is based on hypothetical scenario, while the travel cost method is based on the action of re-actionists (Das, 2014).

2.4. WTP versus WTA

Having similar goods and the same setting, apparently one can easily find WTA exceeds WTP by a certain amount even for goods and services with quite small nominal values where the variance falls on behavioral model (McConnell, 2002). Particularly when the change in services comes from change from public goods or natural resources causes a large change in services or in a very poor countries, changes in access to natural resources can induce large changes in income, and lead to substantial differences in WTA and WTP.

According to the argument stated by McConnell (2002), despite the anomaly between WTP and WTA, We will focus on WTP than WTA in our subsequent action due to the following facts. First, Absence of evidence of differences between WTA and WTP from behavioral methods. Second, there is wide spread of belief that stated preference approaches cannot be used to measure willingness to accept because they are not incentive compatible for this

measure. Thus, the author argues that, in the course of implementation, despite the empirical anomaly, there is no meaningful difference between WTP and WTA.

2.5. Determinants of willingness to pay

The study presented by Wang (2019) discussed about public perception and willingness to pay in Beijing- Tianjin- Hebei, where smog pollution has degraded the air quality. The study shows that willingness to pay is influenced by income level, occupation, awareness and government credibility. The research again addressed that demographic characteristics affects customer's behavior on WTP. The demographic characteristics include Gender, age, health status, occupation, education background, income and other indicators. Finally the research found that residents with jobs affected with air pollution is sensitive jobs to air pollution and female respondents are more concerned about air pollution than male respondents.

Similar studies conducted by Zahedi (2019), on air pollution emission and greenhouse gas (GHG) emissions from private road transport. In identifying the influencing determinants, it uses theory of planned behavior (TPB). Further the research has expanded to three factors, Attitude, subjective norms and perceived behavioral control. Eventually the study concluded that environmental concern significantly affects attitude, subjective norms and perceived behavioral control. To the end, the research attained that individual with positive attitudes and perceived behavioral control showed higher willingness to pay for co2 emission reduction and air pollution mitigation.

Air purifier costs incurred by Chinese public were studied to use as indicator for the determination of WTP (Sisi, 2019). Accordingly, identifying influencing factors were the crucial steps taken to study WTP. Thus, the study carried out by Sisi (2019) has identified two affecting aspects on WTP for clean air. First, the influence of demographic and socioeconomic variables which help us to draw mean WTP is significantly related to income, expenses, and age and education level. In addition the influence of risk perception factors is the second aspect whilst few studies explored that WTP was affected by pollution concentration.

Previous studies conducted by Michael (2011) on willingness to pay for electric vehicles which manifest that individuals were willing to pay from 35$ to 75 $ for a mile of added driving range. Again the study added that with incremental WTP per mile decreases at higher distance, this concludes that vehicular travel practice has an effect on WTP. A research held by (Ferguson, 2018) in Canada directing to how people are open to buy electric vehicles intended to reduce emission shows that people with full time employment and higher education were found willing to pay for electric vehicles. Potoglou (2007) has conducted the study to examine factors affecting households' choice for cleaner vehicles in Canada. Accordingly, the model reveal that reduced monitory costs, incentive on tax relief

and low emission rate encourages households to buy cleaner vehicles. Eventually, previous similar research entails that vehicular intense consumption of fossil fuel leads to CO_2 emission, Due to this reason, rate of emission standards are imposed to cars manufactures (Achtnicht, 2011). At last he has examined that whether rate of CO_2 emission per Kilometer is influencing factor in car choices or not, finally he found out that the emission rate of a has car substantially affected buyers' WTP.

2.6. Policy instruments

Air pollution has become an international agenda that calls an attention of many countries. As the issue related to pollution is deep rooted, government solutions alone will not absolutely eliminate the problem. So, the implementing government body needs to apply policy instrument used to trade-off among the available remedial alternatives for reducing the existing environmental problems. The best instrument would be the one which meets the target with greatest reliability (Roger, 2003).

There are various types of policy approaches in tackling air pollution problem. Under Conventional solution, the command and control is one of the approach that enhances the government to correct environmental market failures through observed economic modelling (Callan, 2013). This modelling should conform to effective policy solution to overcome the problem. As it is discussed on Callan (2013), the policy modelling should start by setting environmental standards. The following listed environmental standards can be described in the policy setting: Ambient standards, Technology based standards or performance based standards.

Ambient standard is type of standard set for the required quality level of some element of the environment found in the outdoor air or body of water (Callan, 2013). It can explicitly defined as the maximum allowable concentration of some pollutant in the ambient environment. Ambient standard is not enforceable nonetheless it serves as a target to achieve a preset pollution limit. The other decisive methods that instructs the abatement control type used by all regulated polluting sources is called Technology-based standards (Callan, 2013). The performance based standard's decides the allowable limit achieved by a regulated polluter without specifying the technology to be used to meet the target (Callan, 2013), the author further states that performance based standards are more flexible than their technology based counterparts. Thus, command and control approach uses pollution limits or technology –based restrictions to directly regulate polluting sources (Callan, 2013). This could be achieved through the implementation of non-transferrable emissions licenses

where the EPA apportion quotas for the total allowable quantity of emission among the individual sources (Roger, 2003).

Second in the Institutional approaches that facilitate internalization of externalities, bargaining is a key solutions, but, bargaining is inefficient without the existence of property rights (Roger, 2003). And again bargaining is known to be facilitated by the existence of a relatively small number of affected parties. However, certain pollution like vehicular emission attributes to wide coverage, so such kind of bargaining is difficult to identify all affected parties and needs significant amount of money to undertake bargaining exercise (Roger, 2003). Moreover, when the number of affected individuals is large, the scope for the efficient bargaining behavior is very restricted. Thus Roger (2003) states that bargaining is hardly possible to bring efficient result in conserving public goods. To improve the efficiency of bargaining a couple of requirement should meet, First property rights of resources should be defined and the next is government should enforce institutional structure that maximizes the scope of bargaining behavior (Roger, 2003). On the top of that liability will play a central role by the judicial system to bring efficient outcome in our bargaining process.

Market approach uses incentive-based policy tools to motivate abatement through market forces. Command and control is not cost effective due to the use of technology and use of uniform standards (Roger, 2003). But, technology-based standards prevents polluter from minimizing the cost of achieving a given abatement level.

Under strict command and control decisions, uniform standards are cost ineffective since they impose uniform standards from minimizing the costs of achieving a given abatement level (Roger, 2003). Apart from more traditional command and control approaches, market approaches uses price or other economic variables to provide incentives for polluters to reduce harmful emissions (Roger, 2003).

2.7. Property wrights

According to Heltberg (2002) economic activities of developing countries depend in their natural capital. To mention some; Land, water, Air, forest, grazing areas and Plants animals are widely utilized and subjected to unsustainable exploitation, pollution and conversion to other uses. Again Callan (2013) explained that, Non rivalness is the consumption of a good by one individual, doesn't affect another person from consuming it at the same time. Again non excludability is explained as avoiding prevention of others from sharing in the benefits of goods consumption. Gareth Hardin's "Tragedy of the commons' (1968)" theorized that

common resources lacking ownership were subjected to over exploitation. As it was stated by Heltberg (2002), Open access properties is known to lack ownership and control. Examples include: Marine resources in international waters, the air, the atmosphere and open space. In addition, potential users have free and unlimited access to exploit it. These resources are highly vulnerable to degradation. In favor of this David (2000) discussed that, In Maine, US recreational land scape that is considered as common pool resources subjected to reciprocal externalities in the form of short term congestion and long term depletion. These adverse effects result from a combination of open access and rivalness in resource use.

Common property refers to resources under communal ownership such as irrigation system, fisheries, national waters, common forest, wetland etc. Likewise, resources under state ownership is called State property and the one that belong to in individual is named as private property. Pure private goods are characterized by rivalness and excludability (Roger, 2003), such goods are available to all and one person's consumption doesn't reduce another person's consumption. In a pure public goods no one can be excluded from the benefits because of a free ride problems. In accordance with Nick (1997) a free rider is someone who disguises in order to enjoy the benefits without paying for the service. Freeriding tourists in Main, USA have weakens land owners' incentives to invest in resource or value added facilities (Vail, 2000).

Environmental externality may happen if the consumption or production activities of one individual or firm affect the other person's utility or firm's production function so that it failed to meet the pareto optimality (Nick, 1997). The study again support that, Tran's boundary pollution like C02 emission is best characterized as a problem of international externalities, which arises from the lack of property rights in the global commons. Certain natural goods like air lacks ownership, nations are free to pollute their neighbors violating the condition of pareto efficiency. In an effort to mitigate the problem a government of the nation can internalize the problem by imposing pollution taxes, while this is not applicable with the global commons (Callan, 2013).

2.8. Effect of air pollution on health

The adverse health effects of air pollution and its severity varies with the severity level of the pollution in the air and the frequency of exposure to it. Accordingly, exposure to ambient air pollution causes a series of health effects, ranging from subclinical effects, physiological changes in respiratory functions and the cardiovascular system, to clinical symptoms, outpatient and emergency-room visits, hospital admissions, and finally to premature death. However, most health emergency response system responds to the recent evidences that focuses on particularly respiratory and cardiovascular effects associated with exposure to

short-term and long-term exposure to air pollution. World health organization (WHO) estimates that about a quarter of the diseases facing mankind today occur because of prolonged exposure to environmental pollution (Corvalan, 2006). He again added that, there are certain risk factors such as occupational exposures to dust and chemicals, as well as in door air pollution from households, using biomass as energy source induce an estimated 42% of chronic pulmonary (COPD), which causes a gradual loss of lung function (Corvalan, 2006). The severity of air pollution is also depends on age, socioeconomic status and adaptive capacity of the person. Among this, the high risk groups include young children, the elderly, person with predisposed diseases (with much less adaptive capacity) and persons with low socioeconomic status. The cumulative effect of this has led to the increased number of people affected with pollution related diseases worldwide.

In light of the above fact, air pollution is one of the serious global Health problem, Likewise; In Ethiopia National estimate of the Burden of diseases such as acute lower respiratory infection and chronic obstructive pulmonary disease is high (WHO, 2007). According to the report of Ministry of Health (MoH), 1,262,908 (5%) cases of acute upper respiratory infections and a 5 % of Pneumonia cases (this accounts for 7 % of hospital admissions) that might be linked to air pollution occurred in 2010/2011. Moreover, 2 % of Hospital admissions in the same year were due to Tuberculosis (Ministry of Health, 2003), put roughly, air pollution is might be the cause of these hospital admissions. Another study carried out by Misganaw (2012) depicts that, Tuberculosis and respiratory infections as the second (11%) and Third (8 %) causes of the deaths that occurred in public and private hospitals in Addis Ababa for the study period 2006-2009. This roughly equals to the deaths caused by HIV/AIDS (11%).

High levels of PM are thought to be linked to respiratory problems such as ALRI, especially among children (IHME, 2014). A survey carried out by IHME (2014), reported a 7% National prevalence of ARI while a study focused on Addis Ababa in 2012 reported a higher prevalence of ARI (23.9%) among the under five year old children. In the atmospheric pollution Particulate matter (PM) is responsible for increased mortality and morbidity of Cardio Vascular and respiratory diseases. In addition to the aforementioned problems, Air pollution is associated with the following diseases diabetes (Peason, 2010), Premature births (Ponce, 2005) and infant Mortality (Woodruff, 2008). Up to 95 % in poor countries, continue to rely on Solid fuels, including bio mass fuels (Pope, 2000).

2.9. Effect of traffic pollution on road side plants

In combating the climate change plants have a paramount importance in serving as one of the major carbon sink medium in nature, many country have taken green development as the leading agenda to their development strategy. However, due to the impact of economic growth, vehicular population is increasing from time to time, especially faulty and badly maintained vehicles are the dominant contributors to air pollution particularly in urban areas (Iqbal, 2015). Consequently the researcher has added that vehicles release carbon particles, unburned and partially burned hydrocarbons, Tar materials, lead compounds and other elements in the environment due to incomplete combustion of fuel and lubricating oils placed on the surface of plants. To this effect, air pollution has a negative consequences to plant growth. The leaf epidermis is the first target where the pollutant first passes through the stomata where most of the gas exchange takes place through these small pores on exposed surfaces (Ramteke, 2015). According to the study carried out by (Iqbal, 2015), Chlorophyll is defined as the green molecule in plant cells that carries out the bulk of energy fixation in the process of photosynthesis. So, plants that found near to automobile exhaust are observed to change in the level of Chlorophyll exposure to air pollution and cause changes in the level of chlorophyll, plant to a certain species types (Iqbal, 2015). Pollution mainly affects photosynthetic pigments, respiratory activities, enzymatic activities and water uptake capacity (Mohammed, 2015). The researched added that Plants found nearby the vehicle exhaust pipes are exposed to various gases such as nitrous oxide (NO), suspended particulate matter and volatile organic compound deposit on the surface of leaves which affect the output of plants. Moreover, high exposure of plants to SO2 causes bleaching of leaves pigment and conversion of Chlorophyll a to phacophytin which reduce the plant productivity.

2.10. Historical perspectives of environmental concern in Ethiopia

Until 1960's during Imperial Regime government's core target were economics (Dechasa, 2015). Nature was treated as an infinite supply of resources to be used by humans, and a limitless sink for wastes. The attitude to pollution which was emanated from technology was usually not aware and if exist the assumption was to cleanup later. After the mid of 1960's a focus on economics weakened as pollution and biodiversity loss problems became apparent and a deep ecology supporters has emerged.

During the Derg Regime still economy at first then environmental conservation would follow. Eventually, during the Current Regime, The main ideology utilized are economics, resource management and Eco development. Climate regulating initiatives are considered as fundamental and there were a lot of initiative to curb environmental related challenges. Several accord in global commons law and consensus our government have taken place. In

addition, while the constitution was ratified in 1995 GC, It has provided with the basic and comprehensive principles and guidelines for environmental protection and management. Together with other provisions, and It explicitly states that everyone has the right to live in a clean and healthy environment.

2.11. Conceptual framework

Conceptual frame work guides the researcher and clarifies pertinent issues of the study. Following thorough examination of literatures review related to willingness to pay for pollution reduction, this conceptual frame work model is developed to guide researcher in designing data collection instruments, data analysis and interpretation. To precisely present the conceptual frame work depicted on the figure shown below.

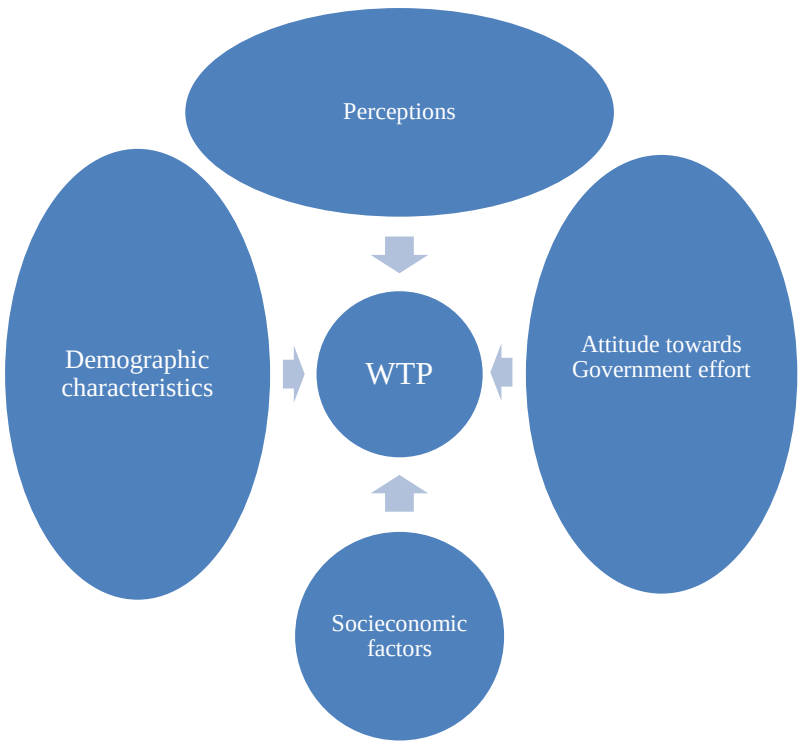

Figure 2-1 **:** Conceptual framework

Source: Developed by researcher

The conceptual frame work shown above presents the summarized methods of determining the preference of private vehicle owners' willingness to pay from their monthly income via tax to induce a dedicated fund to Environmental Protection Authority of Addis Ababa to cut vehicular emission by 30% in the study area. The model indicates the path how air pollution of the city that mainly emerges from tail pipe exhaust and particle pollution will preferred to be reduced through the effect of other unveiled main factors.

More specifically, this framework indicate the relationship between dependent variable i.e. private vehicle owners' willingness to pay and independent variables like: income, gender, age, education, housing condition, marital status, family size, number of vehicles owned, vehicle service year, driving experience, daily travel practice and number of years lived in the study etc.

CHAPTER THREE

3.0. RESEARCH DESIGN AND METHODS

3.1. Description of the study area

The study was conducted in Addis Ababa, the capital city of Ethiopia that hosts the highest number of population, Addis Ababa is the place where African Union and its predecessor the OAU, United Nations headquarter, Embassies and other International organizations are based. Addis Ababa is located with geographical coordinates of 9º03' North latitude and 38º42'East longitude. The city administration extends over 540 Km^2 with 10 sub-cities and 99 regional administrative offices (Ayalneh, 2012).

According to the study carried out by Abera (2010) disclosed that Air pollution in Addis Ababa is assumed to be high due to the existence of old vehicles and poor road infrastructures. To this effect many health-harmful and dangerous air pollutants are being emitted from a vehicular operation (Yohannis, 2018). In view of this, please have a look at the regional distribution of motor vehicles on the graph depicted below:

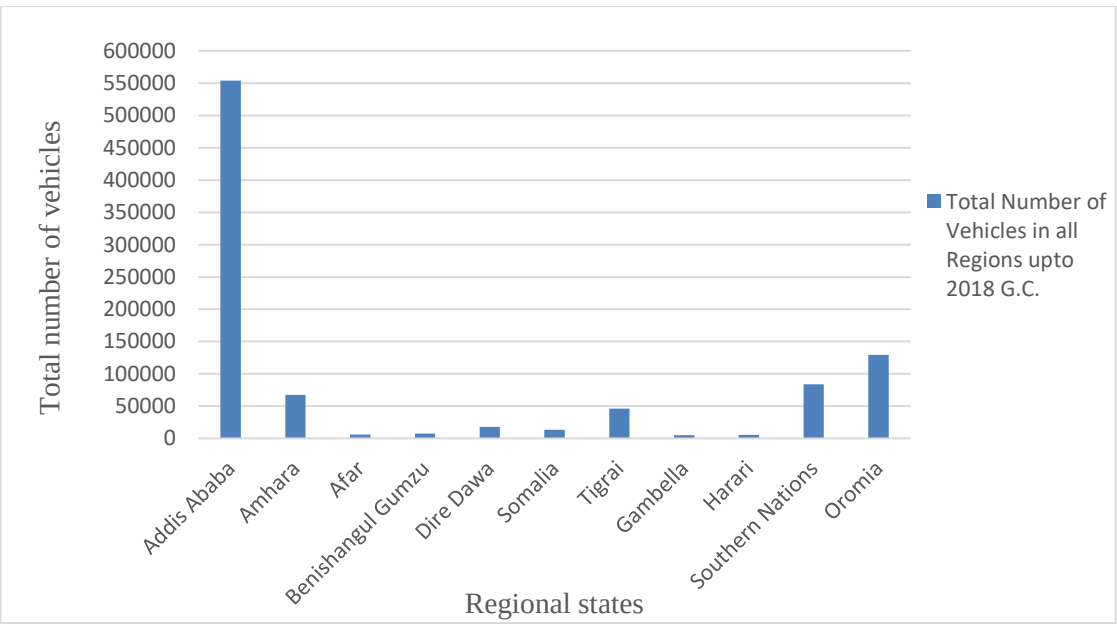

Figure 3-1 : Total number of vehicle fleets distribution across regions

Source: Ethiopian police commission Bureau (Computed by Researcher, 2020)

As a determinant factor in intensifying the problem , increase in vehicular population, the time spent on driving or number of vehicles appear on the street per day have a tremendous effect in worsening the problem. Economic and population growth are the probable driving factors in rising the transportation demand that has resulted with a total number of vehicle fleets operating in the country to 935,888 in 2018. Addis Ababa as it is the main economic

hub of the country and hosts higher number of population, it hosts 553,938 (59.2%) number of vehicle fleets that give a leverage to the observed air pollution problem and the scenario will give an advantage to select Addis Ababa as the preferred study area. The study has particularly considered private vehicle owners in Gullele sub-city as a study target population.

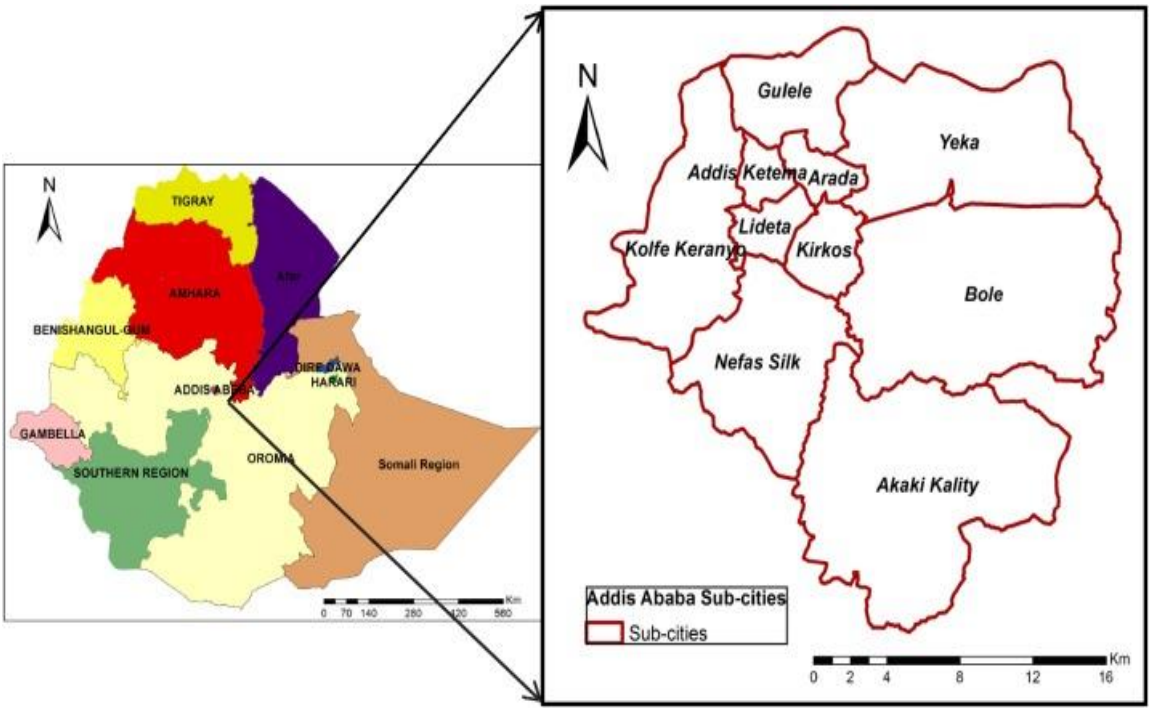

Figure 3-2 : Map of the study area

Source: Ayalneh, 2012

3.2. Research design

In order to successfully meet the objective of the study, the research adopts a descriptive and explanatory research type. Descriptive research type is characterized by having no control over variables and describe the state of affairs as it exist at present (Kothari, 2004). Furthermore, the approach is favorable to measure items like frequency of shopping, preferences of people or similar data.

The study also adopts both qualitative and quantitative research approach which combine both descriptive and inferential statistics. The inferential statistics method used to predict from sample results about a population's preference to pay for reduced air pollution, while the descriptive statistics like frequency, percentage, and mean has been used for the analysis of the data.

3.3. Data source and types

The study adopts field survey to collect primary data. Primary sources of data are the private vehicle owners. Primary data were collected mainly through self-administered structured questionnaires using at least three discrete bid alternatives that closely vary up and down. A closed ended questionnaire was used to avoid biasedness.

The questionnaire was developed based on the objectives of the study set and review of related literature on willingness to pay for reduced air pollution. The main reason for using questionnaire was to get reliable data within a short period of time.

3.4. Population, sample size determination and sampling techniques

3.4.1. Population and sampling

The population of the study is private vehicle owners in Addis Ababa. For the ease of administration, Addis Ababa is divided in to Ten (10) sub-cities, data for Bole subcity was not obtained. While the remaining nine sub cities private vehicle fleet ownership were varied as depicted in the table shown below:

Table 3-1 : Private vehicle owners in Sub-cities

	Sub-cities in Addis Ababa									Total
	Yeka	Nifasilk	Lideta	Kolfe	Kirkos	Kality	Gullele	Arada	A/Ketema	
No. of private vehicles	41,132	74,378	35,756	46,892	68,173	94,404	24,389	53,553	44,323	483,000

Source: Federal Transport Authority, 2020

Since air pollution is not boundary limited, pollution that emerge from the private vehicles were not restricted within a certain particular local area. So, we can assume the resulting air pollution impact emerged from private vehicle across spatial distribution are uniform throughout Addis Ababa. On the top of that, vehicles in Addis Ababa have similar characteristics with regard to their types and service year, majority of vehicles were known to have long serviced year which makes them similar in their pollution capacity. Due to these facts private vehicles in Addis Ababa have similar features to be classified as homogeneous in their pollution capacity. Thus, because of the homogeneity nature, the study adopts simple random method and selected private vehicle owners found in Gullele sub-city having a target population size of 24,389 for analysis purpose.

As it is known sampling design primarily aims at increasing representation of the population by reducing sampling error with a minimum possible cost (Kothari, 2004). Hence, the target populations of the study has selected to be private vehicle owners in Gulelle sub-city.

To obtain reliable data, adequate number of samples was determined by using Yamane's (1967) sample size determination formula:

$$n = N/1+N(e^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{Equation 1}$$

Where n = Sample Size

N = Population size and

e = Margin of error

Then, at 5% significance level, the total sample size n = (24,389)/ (1+ 24,389 $(0.05)^2$) is approximately equal to 394 individuals adding 5% contingency would result with a total number of sample size of 414 to be surveyed. The source indicated that most survey researches use a 95% confidence level and a ± 5% precision level.

3.4.2. Sampling techniques

The target location of the study is Gullele sub city in Addis Ababa, particularly in city government of Addis Ababa, driver and vehicle license and control office at Gullele branch, where all private vehicle owners in the sub-city would look for the following services but not limited to: license renewal, apply for lost driving license, process new and sold vehicle title deed, process vehicle technical competency etc... So, all private vehicle owners have a chance to visit at least once in a year for aforementioned legal services. Inside the office, there is a dedicated window for private vehicle owners appear and request for the services. This has resulted with a convenient situation to easily identify and forward study questionnaires to be filled by the target respondent.

Accordingly, the representative unit was drawn from the population using simple random sampling technique. In favor of this Kothari (2004) states that, random sampling refers to the method of sample selection which gives each element in the population an equality of being picked up and have an equal chance of being included in the sample. In the same manner, this research adopts random sampling technique. List of the entire private vehicle owners' number in Addis Ababa was considered as a sampling frame for this research. Then, representative units were drawn from the population using simple random sampling technique. That was done to give equal probabilities for each private vehicle owners of the study area to be included in the sample.

3.5. Instrument

The research is dedicated to collect primary data. Primary sources refer to private vehicle owners in Gullele sub-city. In the course of the research process, various research literatures written on WTP for clean air was thoroughly referred. A well-organized questionnaire was

used as data gathering instrument for primary data. The questionnaire was developed based on the objectives of the study set and review of related literature on WTP for a reduced air pollution. Both open-ended and closed-ended questions were implemented. The method helps to iterate the initial bid amount that could keep iterating up and down until the respondent's willingness to pay was narrowed down to the certain particular amount.

3.6. Experimental design (Contingent valuation)

Certain natural goods like air quality, biodiversity and beauty of landscapes etc. are not kind of traded natural amenities. In an attempt of measuring the benefits of improved environmental quality, it is the preference of the people that will be measured for a good or bad environmental quality. Among the techniques of measuring the value of non-market environmental goods, the revealed and stated preference techniques are the one used to analyze the same. Revealed preference technique that commonly named as indirect methods include Hedonic pricing and Travel cost method. Accordingly, Hedonic pricing method can be used to value location related amenities, whereas the travel cost method can be used to value recreational amenities.

Thus, the study prefers to adopt stated preference techniques which induce values through survey method by asking people their willingness to pay for any change in environmental quality. Both open-ended and closed-ended questionnaires were implemented. It is the iterative bidding question. One of the most important questionnaire taken place was pre-testing, where 50 questionnaires were distributed to determine the initial bid.

Overall contingent valuation techniques undergo the following summarized steps:

- Dispatch questionnaires that use WTP measures
- Use open-ended and dichotomous choice option
- Adequately pre-test the survey instrument
- Fix the starting Bid point
- Determine the amount of willingness value

3.7. Methods of data analysis

The quantitative data processing was done following the edition and coding work by using statistical techniques. The collected and coded primary data was entered and analyzed using statistical packages for social sciences (SPSS) version 24 and Stata Version 14. SPSS was used for descriptive statistics and Stata was applied for econometrics part. Then, descriptive and inferential methods of data analysis were applied. The output of descriptive statistics were applied to draw percentages, mean, variance and standard deviation, while the inferential statistics used to draw, chi-square which explained the association, effect level. Similarly, probit regression model was applied to determine the probability of peoples'

willingness to pay for the purpose of air quality service improvement with respect to a function of some socioeconomic variables. Eventually, tobit regression model was applied to determine the amount of money an individual spends for environmental quality service improvement with respect to socioeconomic variables.

3.8. Model specification

The study employed probit and tobit regression models since it is interested in modelling dummy variables (Yes or No). Both captures the effects of income, gender, age, education, housing condition, marital status, family size, number of vehicles owned, vehicle service year, driving experience, daily travel practice and number of years lived in the study area on WTP. The second part of the model, on the other hand, focuses on the disaggregated impacts of these explanatory variables on the dependent variable. The overall analysis integrates dependent variable (WTP) with the independent variables like determinants of income, age, marital status, educational background, housing, gender, family size, vehicle service year, number of vehicle owned, number of years lived in Addis Ababa and daily driving practice. The model of the analysis derived as follow:

$Ui = Ui$ (L, Z, Q, I)……1

Where Ui is the utility of private vehicle owners', L is total private vehicles of an individual, Z is socioeconomic characteristics of the private vehicle owners', I is income, whereas Q is current ambient air quality. Here, the intention is to improve air quality from current Q quality to Q*. where, Q* is the quality of air after the intervention and Q as the quality before the current quality or services of the air quality may be deteriorated in the future unless measure should be undertaken. Accordingly, it is assumed that the individual would be willing to pay the suggested reduction from monthly income so as to maximize the common use of utility under the following condition or reject it otherwise;

Ui 1 (L − t, I − Z, Q ∗) + ε1 ≥ Ui 0 (L,I, Z, Q) + ε0 … … …… … … … … … … … 2

Where Ui , L, Z, Q and Q* are as defined above, t is the initial bid for cash requirement for air quality service improvement practices respectively; ε 1 and ε0 are the error terms which are with zero means and independently distributed. Therefore, the probability that a private vehicle owners will decide to participate for clean air service is the probability that the conditional indirect utility function for the proposed intervention is greater than the conditional indirect utility function for the status quo. Mostly the utility functions of individual consumers are usually unobservable. The utility function of the i^{th} private vehicle owner which is assumed to be a function of observable private vehicle characteristics; resource endowment and environmental quality, XTi and a disturbance term εTi can be specified as;

$T = f(XTi) + \varepsilon Ti$ … … … … … … … … … … … … … …… … … …. … … … … ..3

Where T= 0, 1, and i= 1, 2, 3….n

The focus in this model is on the factors that determine the probability of accepting the initial bid. The i[th] private vehicle owner will be willing to accept the initial bid when Ui 1≥Ui 0. Therefore, the choice problem can be modelled as binary response variable. Y, Where,

Yi = 1, if Ui 1 (L − t, I − r, Z, Q ∗) + ε1 ≥ Ui 0 (L, Z, Q) + ε0 Yi = 0, otherwise ……..…4

The probability of that a given private vehicle owner is willing to participate or contribute with income to cut vehicular emission is defined as:

(Yi = 1) = (Ui 1 ≥ Ui 0) … … … … ……... ….. … … … …5

If we substitute equation (5) to (4)

(Yi = 1) = (α1Xi + ε1i > α0 Xi + ε0)…….....6

To rearranging equation, 6

Prob(Yi = 1) = Prob(ε1i − ε0i > α0 Xi − α1Xi) $Prob(Yi$ = 1) = $Prob(\varepsilon 1i - \varepsilon 0i > Xi$ (α0 −α1)..……..……7

Assuming $u1$ = $\varepsilon 1i$ − $\varepsilon 0i$ and β = (α0 − α1) (Yi = 1) = ($u1$ >) = F(βX)……..……...……..8

Where, F is the cumulative distribution function (cdf). This provides an underlying structural model for estimating the probability and it can be estimated either using a probit or logit model, depending on the assumption on the distribution of the error term (ε) and computational convenience (Green, 2003). Assuming a normal distribution of the error terms, the probit model was employed to identify factors affecting the WTP of private vehicle owners to cut vehicular emission. Given the model by Cameron and Quiggin (1994) and Green (2003) takes the following form for one dichotomous-choice:

$$Yi* = \beta' Xi + \varepsilon \text{ ……..……9}$$

Yi=1 if $Yi*$ ≥ ri, Yi=0 if $Yi*$ < ri for cash bid.

Where: $Yi*$ = i[th] respondents true unobserved point valuation for the environmental resource in question. β = unknown coefficient for X ti and ri = the offered threshold bid, assigned arbitrarily to the ith respondent Yi = discrete response of a respondent for the WTP question (1=yes, 0 = no) i= unobservable random component distributed N(0,σ) Xi = observable attributes of the respondent

3.9. Estimation of aggregate willingness to pay

Using the WTP estimates of goods, a range of total economic value (TEV) can be estimated. To estimate the mean WTP of private vehicle owners, McConnell (2002) has developed the relationship. And entails the variables required for the same. So, the general expression for the normal probit model is as derived below: -

The general expression for the model is formulated following Greene (2003) as shown below:

$$Y_1 = \alpha_1 + \beta_1 \text{bid1} + \sum_{i=0}^{n} ßi x i + \varepsilon_1 \quad \text{.....1}$$

Where: Y_1 is response to the WTP for questions; bid1 and bid2 are the bids in the first and second bid questions; Xi and Xj represent explanatory variables; α_1, α_2, ßi and ßj are the coefficients to be estimated.

The econometric model for double-bounded dichotomies choice data given by Haab and McConnell (2002), is as follows:

$$WTP_{ij} = \mu_i + \varepsilon_{ij} \quad \text{.....2}$$

Where, WTPij is the j^{th} respondent's WTP and i=1, 2 represents first and second answers;

μ1, μ2 = mean value for first and second response;

ε_{ij}= unobservable random component

Setting μi = Xijßi allows the mean to be dependent upon the characteristics of the respondents (demographic and socio-economic variables).

To construct the likelihood function, the probability of observing the possible two bid response sequences appear as (yes-no, yes-yes, no-no, no-yes).

The probability that the respondent j answers to the first bid and to the second bid given by (Kothari, 2004):

$$\Pr(\text{yes, no}) = \text{pr}\,(WTP_{1j} \geq t^1, WTP_{2j} < t^2) = \text{pr}\,(\mu_1 + \varepsilon_{1j} \geq t^1, \mu_2 + \varepsilon_{2j} < t^2)$$

$$\Pr(\text{yes, yes}) = \text{pr}\,(WTP_{1j} > t^1, WTP_{2j} \geq t^2) = \text{pr}\,(\mu_1 + \varepsilon_{1j} > t^1, \mu_2 + \varepsilon_{2j} \geq t^2)$$

$$\Pr(\text{no, no}) = \text{pr}(WTP_{1j} < t^1, WTP_{2j} < t^2) = \text{pr}(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} < t^2)$$

$$\Pr(\text{no, yes}) = \text{pr}(WTP_{1j} < t^1, WTP_{2j} \geq t^2)$$

$$= \text{pr}(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} \geq t^2) \ldots \ldots \ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

The j^{th} contribution to the Likelihood function is given as:

$$(\mu\ /t) = (\text{pr}(\mu_1 + \varepsilon_{1j} \geq t^1, \mu_2 + \varepsilon_{2j} < t^2) * (\text{pr}(\mu_1 + \varepsilon_{1j} > t^1, \mu_2 + \varepsilon_{2j} \geq t^2) L_j (* (\text{pr}(\mu_1 + \varepsilon_{1j} < t^1, \mu_2 + \varepsilon_{2j} < t^2) * (\text{pr}(\mu_1 + \varepsilon_{1j} > t^1, \mu_2 + \varepsilon_{2j} \geq t^2) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .4$$

Where;

t^1= first bid price/ initial bid per month, t^2= second bid price

YN=1 for yes -no answer, 0 otherwise;

YY=1 for yes-yes answer, 0 otherwise

NN=1 for no-no answer, 0 otherwise;

NY=1 for no- yes answer, 0 otherwise.

Assuming error terms normally distributed with mean 0 and respective variance σ_1^2, then WTP1j has a normal distribution with mean μ1, variances σ_1^2 and correlation coefficient ρ.

Thus, the j^{th} contribution to the normal probit Likelihood function becomes.

$$L\ (\mu/\ t) = \Phi\varepsilon_1\varepsilon_2\ (d_{1j}\ ((t^1 - \mu_1)/\ \sigma_1), d_{2j}\ ((t^2 - \mu_2)/\ \sigma_2), d_1 j d_2 j \rho) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where, $\Phi\varepsilon_1\varepsilon_2$ =Standardized normal distribution function with zero means y1j=1 if the response to the first question is yes, and 0 other wise y2j=1 if the response to the second question is yes, and 0 otherwise d1j = 2y1j-1, and d 2j= 2y 2j-1 ρ = correlation coefficient **σ**= standard deviation of the errors;

Using the formula specified by Haab and McConnell (2002), the mean willingness to pay (MWTP) from the normal probit model were calculated as:

$$MWTP = -\alpha/\beta \quad \text{.....6}$$

Where α = coefficient for the constant term, ß= coefficient offered bids to the respondent

Finally, the aggregate WTP was calculated by multiplying the MWTP by the total number of private vehicle owners who are expected to have a valid response in the study area.

3.10. Definition of Variables

3.10.1. Dependent Variable

The purpose of this research was to investigate the willingness to pay of private vehicle owners for an improved environmental amenities. As a result, the dependent (outcome) variable is the WTP which is the function of other independent variables.

3.10.2. Independent Variables

According to Kothari (2004), an independent variable is the one that is antecedent to the dependent variable. In this study the independent variable that presumed to influence the outcome or end result of WTP is mentioned as follows: income, gender, age, education and housing condition and marital status. That means, private vehicle owners' preference to pay for an improved environmental amenities may vary depending upon income, gender, age, education, housing condition, marital status, family size, number of vehicles owned, vehicle service year, driving experience, daily travel practice and number of years lived in the study.

Age: Age of private vehicle owners is a continuous variable which shows the age of private vehicle owners in years. The effect of age on willingness to pay for clean air may be negative or positive. Commonly older people were willing to pay for clean air service. Similarly previous studies conducted by Desaigues (2011) for the purpose to increase life expectancy of residents by reducing air pollution has shown that age has no significant effect but has a positive sign. It means that as the respondents' age increases, their willingness to pay will also increases.

Gender: This describes the sex of private vehicle owners, it is either a male or female. The variable is considered in the analysis to verify its effect on WTP for clean air service provision. Where similar studies carried out by Desaigues (2011) in environmental service improvement, reveal that WTP is significantly higher for male respondent. This leads to a conclusion that sex of private vehicle owner has a positive influence on WTP.

Marital status: This is one of the driving factor influencing WTP for emission reduction. Private vehicle owners may be single, married, widowed or divorced, where each these variable have their own effect. Studies associated with air pollution reduction shows that married respondents have significant and positive effect on WTP. This implies that married individuals were willing to pay for clean air service than single, divorced and widowed private vehicle owners.

Family size: This is a continuous variable where it signifies the number of family members found under private vehicle owners. In the previous researches family size has an effect on WTP dedicated for emission reduction purposes. The study conducted by Gupta (2016), shows that number of people in the family has a positive impact on WTP.

Level of education: This is a categorical variable which deals about the number of years spent in a formal school and the qualification attained. Similar studies show that private vehicle owners who have higher educational status can better understand the problem and found to be willing to pay for environmental service improvement. Previous studies like Desaigues (2011) reveal that people with higher educational status have more probability to pay for environmental service improvement.

Occupation: This is a categorical variable that influence WTP depending upon the type of occupation a private vehicle owner was engaged on. Accordingly, Wang (2019) addressed that respondents' willingness to pay were influenced through type of occupation. Furthermore, Mark (2018) in his study indicates that people with full time employment (occupation type) is willing to pay for environmental quality service improvement.

Housing condition: This is an influencing categorical variable of WTP, currently sustainability is one crucial factor in housing condition. Among several studies on the matter, Wilhelmsson (2010) has clearly stated that there is positive influence and respondents were willingness to pay for environmental attributes of housing condition.

Income level: This is a continuous variable where Wang (2019) in his studies of investigating public perception and the willingness to pay in Beijing – Tianjin – Hebei region of a heavy smog polluted areas in China. In his final studies Wang (2019), witnessed that personal income level has significant effect on willingness to pay. Furthermore, among several studies, Sisi (2019) in his study of determining WTP with air purifier costs incurred by the public was added that mean WTP is significantly related to income level.

Number of vehicles owned: Reducing the number of vehicle fleet on the straight will decrease the amount of pollution occurred on our environment. Many countries promote public transport system to discourage private vehicle owners. For example, the study conducted by Mark (2018) states that on average Sydney travelers were willing to pay 6.40$ for an hour of access to car share. However, estimated WTP for unlimited use of public

transport is 5.9$ per day. To this effect, the research considers the number of vehicle owned have an effect on WTP.

Vehicle service year: The continuous variable attributable to WTP, similar previous study carried out in Canada by Dimitris (2007) focused to examine factors affecting households' choice for cleaner vehicles. The final analysis result reveal that reduced monitory costs, tax relief and low emission rates encourages households to buy a cleaner vehicle (recent manufactured).

Rate of pollution: Due to the intense usage of fossil fuel and Co_2 emissions, EU countries have imposed performance standards, to car manufactures (Achtnicht, 2011). Further, the study tested that whether co_2 emissions per Km is an influencing factor in a car choices or not. Accordingly, the study showed that rate of emission of a car substantially affects WTP of an individual.

CHAPTER FOUR

4.0. RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter deals about data analysis, discussions and interpretation of results obtained from descriptive statistics and econometric model. The chapter is divided in to three sections, the first section discusses about descriptive statistics, where the analysis uses mean, percentages, standard deviation and frequency, while the second part discusses about econometric analysis of determinants of private vehicle owners WTP for the improvement of air quality services, The analysis of this part is presented through Probit and Tobit econometrics models. Finally, the third part is where mean and aggregate WTP is calculated sequentially.

4.2. Descriptive statistics of explanatory variables

4.2.1. Overview of response rate

The research investigates the willingness to pay of private vehicle owners to cut their vehicular emission by 30%. As a result, the dependent (outcome) variable is the WTP which is the function of other independent variables. Based on the above fact, the final instrument was distributed referring the three discrete bid values in dichotomous questionnaires. Hence, among the entirely distributed 414 final questionnaires, it was able to collect 371 responses, where 339 (82.3%) of respondents were willing to pay, while the other 32 (7.8 %) of respondents were not willing to pay for the mitigation program.

4.2.2. Demographic characteristics

The analysis result shown on Table 4-1 below shows that, the minimum and maximum age of respondents were 27 (twenty seven) and 64 (sixty four) years old respectively. The mean and standard deviation of age value was 39.08 (7.22) year respectively.

Table 4-1 : Demographic characteristics of surveyed respondents

Variables	N	Mean	Std. Deviation	Minimum	Maximum	Sig.
Age of Respondents	371	39.08	7.220	27.00	64.00	0.696

Source: Own survey, 2020

Again Table 4-2 below depicts that among the contacted respondents 311 (83.83%) were male while the remaining 60 (16.17%) were female respondents.

Educational status of respondent has significant effect on willingness to pay for environmental quality service improvement, Accordingly, the analysis result presented on Table 4-2 entails that 146 (35.4 %) of respondents educational status were 10+3, 91 (22.1%) of respondents have attained Masters, 58 (14.1%) of respondents were BSc Degree holder, 52 (12.6 %) of respondents were diploma holder and 15 (3.6%) of respondents were PhD holder while 9 (2.2%) were 10/12 grade completed.

Table 4-2 : Descriptive statistics of level of education, occupation and accommodation

Variables	Categories	Frequency	Percent	Chi-square	P value
Gender	Male	311	83.83	0.446	0.660
	Female	60	16.17		
Level of Education	10+3	146	35.4	51.342	0.000
	Masters	91	22.1		
	Degree	58	14.1		
	Diploma	52	12.6		
	PhD	15	3.6		
	10/12	9	2.2		
Main Occupation type	Personal business	171	41.5	3.513	0.742
	Employed in private sector	103	25		
	Employed by Government	50	12.1		
	Employed by nongovernment	25	6.1		
	Employed development agency	17	4.1		
	Unemployed	4	1.0		
	Student	1	0.2		
Housing Condition	Rental	212	51.5	10.125	0.018
	Own	79	19.2		
	With family	73	17.7		
	Government	7	1.7		

Source: Own survey data, 2020

In addition, the descriptive analysis presented on Table 4-2 deals about housing condition of respondents, to this end, 212 (51.5 %) of respondents live in a rental house, 79 (19.2%) of respondents live in their own house, 73 (17.7 %) of respondents live in their family house, and 7 (1.7%) live in the government houses. Likewise, Table 4-2 deals about respondents main occupation type as described below: 171 (41.5%) of respondents have their own personal business, 103 (25%) were employed at private sector, 50 (12.1%) were employed at government office, 25 (6.1%) were employed in NGO, 17 (4.1%) were employed in development agency, while 4 (1 %) were unemployed and 1 (0.2%) of respondent was a student.

Eventually, the analysis result identified that level of education and housing condition have significant effect on WTP. To this end the associated 2 sided asymptotic significance values were 0.000 and 0.018 respectively, where the results were smaller than the alpha value of 0.05. This implies that the proportion of willingness to pay with regard to educational status and housing condition were significantly different. Eventually this shows that there is an association between willingness to pay and respondents' educational status and housing condition. With regard to effect size, the two significant variables were classified as category two. Consequently, level of education and housing condition have small effect on willingness to pay (WTP).

4.2.3. Socioeconomic factors

The analysis result on Table 4-3 reveals that respondents have a minimum family size of 1 and maximum of 4 family members. The mean value of family size is 2.55, while it has a standard deviation value of 1.170.

Table 4-3 : Descriptive statistics of socioeconomic factors

Variables	N	Mean	Std. Deviation	Minimum	Maximum	Sig.
Family Size (D)	371	2.55	1.170	1.00	4.00	0.730
Respondents Income Level	371	34,600.00	6,661.754	8,000.00	62,000.00	0.294

Source: Own survey data, 2020

Likewise, Table 4-3 describes that respondents have a minimum income level of 8,000 ETB and maximum of 62,000 ETB per month, The mean and standard deviation of income level was 34,600.00 (6,661.754) ETB respectively.

4.2.4. Vehicular emission as a prominent causes of air pollution

The level of pollution has a direct relation with the number of vehicle occupying the street. Literatures witnessed that increase in vehicular population will cause congestion where environmental pollution and health risks are a direct replica of the traffic congestion (Brohi, 2018). According to the report obtained from the Federal Police Commission Bureau, the number of national vehicle fleet has significantly increased as depicted on the graph shown below:

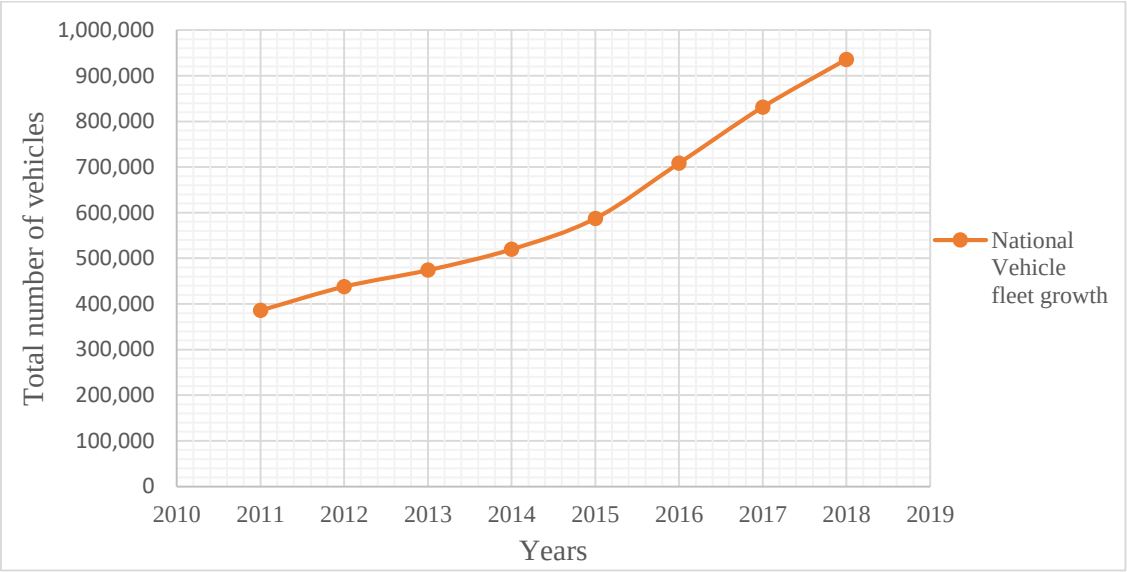

Figure 4-1 : Trend of vehicle fleet growth in Ethiopia

Source: Ethiopian police commission Bureau, Computed by author

The data obtained from police commission bureau indicates that 59.2% of vehicles were found in Addis Ababa and the number of vehicle ownership have also significantly increased causing a rise in tail pipe emission in the city. In view of this, the analysis shown below on Table 4-4 indicates that respondents have owned a minimum of 1 and maximum of 4 vehicles. The mean vehicle ownership value is 0.191 while it has standard deviation value of 0.5822.

Table 4-4 : Descriptive statistics of continuous influencing factors

Variables	N	Mean	Std. Deviation	Minimum	Maximum	Sig.
Number of Vehicle Ownership	371	0.191	0.5822	1.00	4.00	0.096
Respondents' Years of Driving Experience	371	7.69	5.465	1.00	30.00	0.965

Respondents' Daily Travel Practice Km/day	371	49.54	11.800	28	93.00	0.710
Respondents' Number of Years Lived in Addis Ababa	371	29.33	11.085	1.00	60.00	0.894

Source: Own survey data, 2020

In the same manner Table 4-4 explores that the surveyed private vehicle owners have lived in Addis Ababa for a minimum of 1 year and maximum of 60 (Sixty) years. The average and standard deviation of respondents number of years lived in Addis Ababa was 29.33 (11.085) years respectively. Beside to the number of years lived in the study area, the research tries to sort out private vehicle owners' driving experience, accordingly, the surveyed respondents have a minimum of 1 (One) year private vehicle driving experience and a maximum of 30 (Thirty) years. And the average private vehicle driving experience was 7.69 years. In addition, Table 4-4 discusses the daily driving practices of a driver which may vary according to the vehicle types, working behavior and any other factor. In connection to this, this study reveals that private vehicle owners have an experience of driving a minimum of 28 Km per day and maximum of 93 Km per day. The average and standard deviation of private vehicle owners daily driving practice were 49.54 (11.800) Km per day respectively. With this regard, the study conducted by Symeonidis (2008) reveals that vehicle usage and the number of annual kilometers driven have an effect on the pollution rate. Usually annual mileage is dependent on the age, and results with engine degradation and vehicle type. Because small engine capacity is mostly used in the city while larger cars are used more for longer distances.

Similar studies assessed that, old vehicles with old engines and probably with bad maintenance emit more pollutants compared with newer vehicles of the same technology (Symeonidis, 2008). Moreover, Abera (2010) disclosed that air pollution in Addis Ababa was assumed to be high due to the existence of old vehicles and poor road infrastructures. In light of this fact, the research tried to assess the number of vehicle service years operating in the city, consequently, the research identified that the minimum vehicle service year was 1 while the maximum service year was 40 years, and the average and standard deviation of vehicle service year were 13.41 and 5.301 years respectively.

4.2.5. Respondents' perception about vehicular air pollution

The target private vehicle owners during their stay in the study area have a feeling that vehicular air pollution have affected their life. To this end Table 4-5 depicts that, 219 (53.2 %) of respondents have a feeling that air pollution is affecting their life, whereas 151

(36.9%) felt that air pollution do not affect their life at all, Those respondents who thought that air quality has been affecting their life have expressed the air quality rate in their residential area as follows, 223 (54.1 %) rated as a little better, 51 (12.4%) of respondents rated the air quality as much better, 48 (11.7%) as acceptable level, 46 (11.2 %) as bad condition and 3 (0.7) rated as very bad condition.

Following a feeling of persistent rise of the problem, Table 4-5 presents about respondents' perception on the severity of the problem as follow. 279 (67.7 %) of respondents expressed that they were moderately affected by air pollution, whereas 75 (18.2%) of respondents expressed that air pollution did not affect their life at all, while 17 (4.1 %) of respondents have expressed that they were seriously affected by the current air pollution.

The analysis result on Table 4-5 depicts that 280 (68%) of respondents strongly agreed to consider air pollution as a major problem, 73 (17.7%) of respondents agreed to take air pollution as a problem, whereas 14 (3.4%) of respondents averagely agreed to classify air pollution as a problem while 2 (0.5%) of respondents disagreed to decide air pollution as a problem and 2 (0.5%) of respondents strongly disagreed to classify air pollution as a problem. As it was shown on the above, majority of respondents considered air pollution as a problem.

Table 4-5 : Respondents perception about vehicular air pollution

Variables	Categories	Frequency	Percent	Chi-square	P value
Does air pollution affects respondents' life	Yes	219	53.2	1.330	0.249
	No	152	36.9		
Rate of Air pollution in Residential area	A little better	223	54.1	1.467	0.833
	Much better	51	12.4		
	Acceptable	48	11.7		
	Bad	46	11.2		
	Very Bad	3	0.7		
Alleged causes of air pollution	Vehicular emission	160	38.8	4.912	0.555
	Population growth	84	20.4		
	Industrial source	64	15.5		
	Waste disposal	45	10.9		
	Construction	10	2.4		
	Indoor energy use	7	1.7		
	Incineration	1	0.2		

Severity of air pollution effect	Moderately affected	279	67.7	0.018	0.991
	Not affected	75	18.2		
	Seriously affected	17	4.1		
Do you feel pollution as a problem?	Strongly agree	280	68	2.129	0.712
	Agree	73	17.7		
	Average	14	3.4		
	Disagree	2	0.5		
	Strongly disagree	2	0.5		

Source: Own survey data, 2020

The contribution of various sectors to air pollution may vary from country to country. In the study area respondents have the perceptions about the alleged causes of air pollution as presented on Table 4-5, Accordingly, 160 (38.8%) predicted that vehicular emission was the main cause of air pollution, 84 (20.4 %) predicted that population growth would be the cause for air pollution, 64 (15.5%) presumed that the prevailing air pollution emerges from industrial sector, 45 (10.9 %) believed that waste disposal was polluting the air, 10 (2.4%) of respondents thought that construction industry was the main causes of air pollution, while 7 (1.7%) of the respondents have a perception that using biomass as energy source contributes and causes outdoor air pollution, and 1 (0.2%) respondent has a perception that incineration could be the main causes of air pollution.

4.2.6. The health effect of air pollution

Ambient air pollution is a series threat to human health. In Ethiopia National estimate of the Burden of diseases such as acute lower respiratory infection and chronic obstructive pulmonary disease is high (WHO, 2007). The report presented by Ministry of Health (MoH) show that, 1,262,908 (5%) cases of acute upper respiratory infections and a 5 % of Pneumonia cases (this accounts for 7 % of hospital admissions) that might be linked to air pollution occurred in 2010/2011.

In line with the above findings this study has find out the effect of air pollution as presented on Table 4-6. Accordingly, among the entire respondents 130 (31.6%) of respondents have difficulty in breathing, 79 (19.2%) of respondents were hampered to perform their daily outdoor tasks, 67 (16.3%) of respondents have got asthmatic, 55 (13.3 %) of respondents have faced irritation to eyes/nose/throat 26 (6.3%) have a feeling of depression, 7 (1.7 %) of private vehicle owners were subjected to skin problem while 6 (1.5 %) have encountered visibility problem, and 1 (0.2 %) respondent were planned to relocate residence area.

Table 4-6: The health effect of vehicular air pollution

Variables	Categories	Frequency	Percent	Chisquare	P value
Health effect of air pollution	Difficulty in breathing	130	31.6	6.716	0.459
	Fail to perform	79	19.2		
	Get Asthmatic	67	16.3		
	Irritation to eyes/nose/Throat	55	13.3		
	Feeling depression	26	6.3		
	Skin problem	7	1.7		
	Visibility	6	1.5		
	Planned to change residence location	1	0.2		

Source: Own survey data, 2020

4.2.7. Respondents' attitude towards government effort in mitigating vehicular air pollution

This study thoroughly addresses respondents' attitude and mitigation measures. Accordingly, Table 4-7 entails that, target respondents have an interest to exert their effort in any abatement action. Hence, the findings were 170 (41.3%) of respondents strongly agree to participate in any abatement action, 113 (27.4 %) of respondents agree, 81 (19.7%) of respondents have average stand, 4 (1.0%) of respondents disagree and 3 (0.7%) of respondents strongly disagree to participate in abatement action to cut vehicular pollution by 30%. Thus, this needs a combined effort to curb the problem. To this end, the analysis result on Table 4-7 discussed that 299 (72.60 %) of respondents were strongly agreed that environmental quality improvement should be the responsibility of every citizen, 66 (16.00 %) of respondents were agreed to consider as citizens responsibility, 2 (0.5 %) have average stand on the subject, while 2 (0.5 %) disagreed, again 2 (0.5) have strongly disagreed on the principle considering environmental quality improvement as the responsibility of every citizen.

Table 4-7: Respondents attitude towards government effort in tacking vehicular air pollution

Variables	Categories	Frequency	Percent	Chi-square	P value
Interest to lessen the problem	Yes	326	89.3	0.220	0.639
	No	39	10.7		

Interest to take abatement action	Strongly agree	170	41.3	5.795	0.215
	Agree	113	27.4		
	Average	81	19.7		
	Disagree	4	1.0		
	Strongly disagree	3	0.7		
Interest on vehicle emission measurement	Disagree	106	25.7	7.150	0.128
	Agree	104	25.2		
	Average	100	24.3		
	Strongly agree	38	9.2		
	Strongly disagree	23	5.6		
Citizens responsibility in environmental quality improvement	Strongly agree	299	72.6	8.593	0.072
	Agree	66	16.0		
	Average	2	0.5		
	Disagree	2	0.5		
	Strongly disagree	2	0.5		
Installation of vehicle emission reduction technology	Agree	165	40.0	4.286	0.369
	Average	121	29.4		
	Strongly agree	48	11.7		
	Disagree	34	8.3		
	Strongly disagree	3	0.7		
Vehicle service year restriction	Agree	104	25.2	11.716	0.020
	Strongly agree	88	21.4		
	Average	80	19.4		
	Disagree	74	18.0		
	Strongly disagree	25	6.1		

Source: Own survey data, 2020

In view of the respondents interest to participate in any emission cutting action taken by the government, Table 4-7 complements that respondents have a subsequent attitude that, 328 (89.3 %) of private vehicle owners were interested to participate in any lessening action of the problem, while 39(10.7 %) of respondents did not have an interest to do anything in lessening the prevailing air pollution in Addis Ababa.

Vehicular emission measurement was a central issue in tackling the air pollution problem. To this end, the study result on Table 4-7 tries to indicate respondents opinion on emission measurement as follows: 106 (25.7%) of respondents disagreed to implement emission

measurement on vehicle tail pipe exhaust, 104 (25.2 %) of respondents agreed, 100 (24.3 %) have average stand on the matter while 38 (9.2%) were strongly agreed, and 23 (5.6 %) of respondents strongly disagreed to implement emission measurement for vehicle tail pipe exhaust.

In favor of the above idea, Table 4-7 further explores the attitudes on the installation of emission reduction technology as discussed below, 165 (40%) of respondents agreed to install vehicle emission reduction technology, 121 (29.4 %) have average stand, while 48 (11.7 %) of respondents strongly agree, while 34 (8.3%) were disagreed, and 3 (0.7 %) of respondents strongly disagreed to install vehicle emission reduction technology.

In prior discussion it is evidenced that the rise of vehicular population on the street causes a rapid surge of emission. As part of mitigation measures, many countries apply polluter pays principle and impose levying carbon tax since early 1990s (Muller, 1996), for instance, Sweden and Norway started imposing carbon tax with $ 27 and $ 15 per ton of Co_2. In light of the afore-cited global experience of discouraging vehicular emission, the analysis on Table 4-7 found out that respondents' opinion on the application of polluter pays principle. To this end, 136 (33 %) of respondents disagreed on the application of polluter pays principle, 88 (21.4 %) of respondents were agreed, 78 (18.9 %) has an average view on the matter, while 43 (10.4 %) of respondents were strongly disagreed, and 26 (6.3 %) of respondents were strongly agreed to apply the polluter pays principle to mitigate the intensifying vehicular emission threat.

It is a fact that the condition of vehicle engine declines through time, due to bad maintenance and long service year jeopardizing the efforts taken to lessen greenhouse gas emissions. In a stride to take corrective measures, the Ethiopian Ministry of Transport was working on discouraging the importation of used vehicles through a tax increase, the imposed tax for used cars could go as high as 500%. Regardless of the above efforts, the study result on Table 4-7 shows that, 104 (25.2 %) of respondents agreed the application of vehicle service year restriction, 88 (21.4 %) were strongly agreed, 80 (19.4 %) of respondents have average stand, while 74 (18 %) of respondents have disagreed, and the remaining 25 (6.1%) of respondents strongly disagreed to apply vehicle service year restriction in Addis Ababa.

Vehicle service year restriction has a Pearson chi-square value of 11.716 and an associated asymptotic significance value of 0.020. This result was smaller than the alpha value of 0.05. So, it was possible to conclude that the result was significant, this implies that, the proportion of willingness to pay with regard to vehicle service year restriction was significantly different. So, there appears to be an association between willingness to pay and vehicle service year restriction.

Eventually the polluter pays principle vehicle service year restriction has a significant effect on willingness to pay (WTP). They have a Pearson chi-square value of 10.375 and 11.716 respectively, with an associated asymptotic significance value of 0.035 and 0.020 respectively. The significance value of both were smaller than the alpha value of 0.05. So, it was possible to conclude that both the results were significant, and these imply that the proportion of willingness to pay among private vehicle owners based on polluter pays principle and vehicle service year restriction were significantly different. So, there appears to be an association between willingness to pay and polluter pays principle and vehicle service year restriction. With regard to effect size, both variables were classified as category two. Consequently, the application of polluter pays principle and vehicle service year restriction have small effect on willingness to pay (WTP).

4.2.8. Descriptive analysis of willingness to pay

Table 4-8 reveals that among the total male respondents 276 (88.7 %) were willing to pay from their monthly income through tax to tackle vehicular air emission problem. while the remaining 35 (11.3 %) were not willing to pay for air quality mitigation measures. Among the entire female respondents, 55 (91.7 %) were willing to pay while the remaining 5 (8.3 %) were not willing to pay for air quality service improvement.

Moreover, the study was able to find out willingness to pay varied across individual's marital status as shown on Table 4-8. Accordingly, 187 (88.6 %) of married respondents, 124 (91.2 %) of single respondents, 18 (81.8%) of widowed respondents and 2 (100%) of divorced respondents were willing to pay, while the remaining were not willing to pay for any air quality service improvement. Furthermore, among the stated educational categories Table 4-8 reveals the following respondents were willing to pay based on their educational status: 121 (82.9 %) among the 10+3 completed respondents, 15 (100 %) among a PhD qualified respondents, 90 (98.9 %) among the Masters holder respondents, 57 (98.3 %) among the BSc degree holder respondents, 45 (86.5 %) among the diploma holder respondents, 3 (33.3 %) of respondents that have completed 10/12 grade were willingness to pay from their monthly income via a means of tax to cut vehicular emission by 30%. while the remaining proportions were not willing to pay for vehicular emission reduction mitigation measures.

Consecutively the result on Table 4-8 comes out with the willingness to pay proportion, to this end, among the above contacted respondents, the following respondents were willing to pay according to their occupational distribution: 149 (87.1%) of respondents who have their own personal business, 95 (92.2 %) of respondents employed in private sector, 43 (86%) of respondents working at government offices, 23 (92%) of respondents were employed in

NGO, 16 (94.1%) of respondents were employed at development agency while 4 (100%) of unemployed respondents and 1 (100%) student were willingness to pay. while the remaining figures were not willing to pay for the vehicular emission reduction mitigation measures

The research again indicates that willingness to pay varied across housing condition as illustrated below; 180 (84.9 %) among respondents living in a rental house, 76 (96.2 %) of among the respondents living in their own house, 68 (93.2%) of respondents living with their family house, and 7 (100%) of respondents living in the government houses were replied for "Yes" and agreed to pay from their monthly income via a means of tax to cut vehicular air pollution by 30%. while the corresponding remaining respondents were not willing to pay for similar mitigation measures.

Table 4-8 : Descriptive statistics of Willingness to pay

Variables	Categories	WTP	Willingness to pay		Total
			No	Yes	
Gender	Male	Percent	11.3	88.7	100
		Count	35	276	311
	Female	Percent	8.3	91.7	100
		Count	5	55	60
Marital status	Single	Percent	8.8	91.2	100
		Count	12	124	136
	Married	Percent	11.4	88.6	100
		Count	24	187	211
	Divorced	Percent	0	100	100
		Count	0	2	2
	Widowed	Percent	18.2	81.8	100
		Count	4	18	22
Respondents' Educational level	10/12 Complete	Percent	66.7	33.3	100
		Count	6	3	9
	10+3	Percent	17.1	82.9	100
		Count	25	121	146
	Diploma	Percent	13.5	86.5	100
		Count	7	45	52
	Degree	Percent	1.7	98.3	100
		Count	1	57	58
	Masters	Percent	1.1	98.9	100
		Count	1	90	91
	PhD	Percent	0	100	100
		Count	0	15	15
	Student	Percent	0	100	100

Respondents' Occupational type		Count	0	1	1
	Employed Government	Percent	14	86.0	100
		Count	7	43	50
	Employed nongovernmental Organization	Percent	8.0	92.0	100
		Count	2	23	25
	Employed Private Sector	Percent	7.8	92.2	100
		Count	8	95	103
	Employed Development Agency	Percent	5.9	94.1	100
		Count	1	16	17
	Unemployed	Percent	0.0	100	100
		Count	0.0	4.00	4
	Personal Business	Percent	12.9	87.1	100
		Count	22	149	171
Respondents' Housing Condition in Addis Ababa	Government	Percent	0.0	100.0	100
		Count	0.0	7	7
	With Family	Percent	6.8	93.2	100
		Count	5	68	73
	Own	Percent	3.8	96.2	100
		Count	3	76	79
	Rental	Percent	15.1	84.9	100
		Count	32	180	212

Source: Own survey data, 2020

4.2.9. Willingness to pay estimation and reasons for compliance

Pretest survey was one of the critical steps used to determine the initial bid amount. Accordingly, 50 (Fifty) open-ended questionnaires were prepared and randomly distributed to respondents to specify the amount they pay from their monthly income through tax for Addis Ababa Environmental Protection Agency to cut vehicular emission by 30%. The average initial bid amount obtained from the collected 50 questionnaires were 156 ETB. In narrowing the interval during iteration to fix upper and lower boundaries, the research adopts 10% gap for both lower and upper limit resulting in 140 and 172 ETB respectively. The final instrument was distributed using the above stated three discrete values in dichotomous questionnaires. Hence, 371 respondents were replied for the survey, the survey found out 339 (82.3%) of respondents were willing to pay at least one of the three availed offers, while the other 32 (7.8 %) of respondents were not willing to pay for the mitigation program. As it is shown on Table 4-9, 103 (25 %) of respondents were willing to pay 156 Birr, while 151 (36.7%) of the respondents were willing to pay 172 ETB, and 85 (20.6%)

of respondents were willing to pay 140 ETB. Here were the main reasons for willingness to pay:

- Respondents were confident that the program will result in significant improvement on vehicular pollution problem.
- Respondents were certain that the collected money will directly apply to the intended program.
- Some respondents have a feeling that they have national responsibility to support the program.

Reasons for not willing to Pay

- They believe that they already paid sufficient amount of tax and want to shift the responsibility back to the government.
- Some respondents expressed that they have low income level.
- Want to give priority to other programs.

Table 4-9: Frequency of respondents' willingness to pay

Bids	Bids Amount	Frequency	Percentage
Bid 1	140	80	19.4
Bid 2	156	103	25
Bid 3	172	151	36.7
Total		365	88.6

Source: Own survey data, 2020

4.3. Econometric analysis and result

Prior to the analysis, the model was checked for multicollinearity. Accordingly, the value of Variance Inflation Factor (VIF) for continuous variables was 1.63, which is less than 10 and Contingency Coefficient for Discrete Variables is less than 0.75. Thus, multicollinearity is not serious problem.

Accordingly, probit analysis has an immense advantage to analyze qualitative (dichotomous) dependent variables within regression framework, commonly the dependent variables are binary by nature (Yes/No). If the dependent variable is defined in two binary and numeric variables, the binary WTP classifies respondents in two categorical groups as those who are WTP as one category (1) and those who are not as another category (2).

Literature proves that probit analysis is used to show the probability of people's willingness to pay for air quality service improvement with respect to a change in other variables.

As it was discussed in the previous section, the analysis was conducted using Stata 14. Accordingly, the analysis result shown on Table 4-10 and Table 4-11 conducted with Probit and Tobit regression models were explicitly show the effect of explanatory variables on willingness to pay: Thus, the result on the above referred table comprises of both significant and insignificant values, but the discussion of this part is limited to significant influencing variables.

Table 4-10 : Probit analysis parameter estimates

Number of observation = 371

LR Chi2 (23) = 76.43

Prob > Chi2 =0.0000

Log likelihood = -80.43587 *Pseudo R2 = 0.3221*

Variables	Coefficient	Std. Error	Marginal Effects	
			dY / dX	Std. Error
Initial bid (156)	0.779**	0.307	0.057**	0.020
Age	0.046	0.029	0.005	0.004
Gender (Base Female)	0.081***	0.354	0.872***	0.017
Marital Status (Base category Widowed)	-0.017	0.187	-0.002	0.017
Single	0.530	0.462	0.891	0.027
Married	0.339	0.455	0.865***	0.023
Family size	-0.079	0.113	-0.008	0.010
Level of Education (Base Sec. Compl.)	0.641	0.128	0.059***	0.013
10+3	1.413***	0.521	0.786***	0.039
Diploma	1.941***	0.568	0.889***	0.039
Degree	2.890***	0.741	0.978***	0.023
Masters	3.051***	0.681	0.984***	0.015
Occupation (Student)	0.012	0.060	0.001	0.005
Emp. Gov.	-0.155	0.346	0.839***	0.050
Emp. NGO	0.128	0.805	0.882***	0.105
Emp. Private	0.321	0.303	0.906***	0.028
Emp. Dev. Agency	-0.498	0.626	0.775***	0.119
Housing Condition (Base Government)	-0.220	0.150	-0.021	0.015
With family	0.479	0.359	0.918***	0.033
Own	0.185	0.404	0.883***	0.052
Income level	3.12e-06	0.0000172	-2.90e-07	0.000

Vehicle Service year	-0.058***	0.022	-0.005**	0.002
Private vehicle Driving experience	0.062	0.039	0.006	0.004
Daily travel Practice	-0.00023	0.0094	-0.000022	0.0008
No. Year lived A.A.	-0.032**	0.015	-0.003**	0.001
Pollution affects life	0.415	0.261	0.037	0.022
Rate Pollution	0.073	0.146	0.007	0.0136
Cons	-1.702	1.533		

Source: Own survey data, 2020

**** Significant at 1%, ** Significant at 5%, * Significant at 10%*

In line with the analysis output of Table 4-10 WTP of private vehicle owners depend on several explanatory factors namely: Age, Gender, Marital status, Family size, Level of education, Occupation, Housing Condition, Income level, Vehicle Service year, Private Vehicle Driving Experience, Daily travel practice, Number of Vehicles owned and number of years lived in the study area. Among the above stated variables respondent number of years lived in Addis Ababa and vehicle service year have negative impact at 1%, 5% significance level. While the other variables like level of education have a positive impact at 1% and 5%.

Against the above findings other variables such as Age, Gender, Marital status, Income,Family size, Years education completed, Occupation, Housing condition, Private vehicle driving experience and daily travel practice were not significant at 1%, 5% and 10% of significance level. As it was illustrated by Gupta (2016), MacFaddens's Pseudo R-square values show the level of improvement in the full model as compared to the intercept model, Accordingly, the Pseudo Coefficient of determination (Pseudo R2) of the analyzed data was 32.21%. The likelihood ratio for the models was -80.43587 and the prob>Chi2 is 0.000. To have brief view, the analysis result was explicitly discussed below:

Level of education: The analysis result explicitly shows that level of education has strong effect on WTP. Accordingly, as level of education increased, respondents are more likely willing to pay for air quality service improvement. 1% rise in education status is more likely to rise WTP by 59.5%. When all educational level compared with secondary school completed (Base variable) were more likely willing to pay for vehicular emission reduction program. Similar studies show that private vehicle owners who have higher educational status can better understand the problem and found to be willing to pay for environmental service improvement. Previous studies like Desaigues (2011) reveal that people with higher educational status was more likely to pay for environmental service improvement.

Vehicle service year: The analysis comes out with private vehicle owners having long vehicle service year were less likely willing to pay for clean air service, 1% rise in vehicular service can reduce the probability of WTP by 0.54%. Previous similar study carried out by

Dimitris (2007), in Canada focused to examine factors affecting households' choice for cleaner vehicles (recent manufactured). The final analysis result reveals that reduced monitory costs, tax relief and low emission rates encourage households to buy a cleaner vehicle. Contrarily people with long served vehicles were imposing pressure to our environment, although it does not have a relation to individual WTP.

Number of years lived in Addis Ababa: - This variable also results with the outcome shown below: the more respondents' number of years lived in Addis Ababa, the lesser willingness to pay for clean air service. 1% rise in number of years lived in Addis Ababa decreases WTP by 0.30%. This implies that new comers to live in Addis Ababa were sensitive to air pollution problem since pollution emerges from internal effect (activities), so long lived residents may adapt to the situation.

Table 4-11: Tobit regression analysis parameter estimates

Number of observation = 371

LR Chi2 (29) = 96.46

Prob > Chi2 =0.0000

Log likelihood = -43.86589 *Pseudo R2 = 0.5237*

Variables	Coefficient	Std. Error	Marginal Effects	
			dY / dX	Std. Error
Initial Bid (156)	0.090***	0.034	0.106***	0.035
Age	0.005	0.004	0.005	0.004
Gender (Base Female)	0.016	0.041	0.016	0.041
Marital Status (Base category Widowed)	0.001	0.026	0.001	0.026
Single	0.079	0.065	0.079	0.065
Married	0.065	0.064	0.064	0.064
Divorced	0.156	0.211	0.155	0.210
Family size	-0.005	0.015	-0.008	0.015
Level of Education (Base Sec. Compl.)	0.074***	0.013	0.074***	0.013
10+3	0.453***	0.097	0.439***	0.088
Diploma	0.544***	0.102	0.529***	0.093
Degree	0.599***	0.101	0.585***	0.092
Masters	0.626***	0.099	0.612***	0.089
PhD	0.652***	0.141	0.638***	0.134
Occupation (Student)	0.009	0.008	0.009	0.008
Emp.Gov	-0.022	0.280	-0.022	0.279
Emp. NGO	-0.016	0.283	-0.016	0.282
Emp. Private	0.034	0.278	0.034	0.277
Emp. Dev. Agency	-0.019	0.285	-0.019	0.284
Unemployed	0.054	0.311	0.054	0.309

Personal Bus.	0.012	0.279	0.012	0.279
Housing Condition (Base Government)	-0.041**	0.018	-0.041**	0.018
With family	-0.032	0.113	-0.032	0.113
Own	-0.076	0.111	-0.076	0.111
Rental	-0.116	0.109	-0.115	0.109
Income level	1.68e-07	2.26e-06	1.68e-07	0.000
No. Vehicle owned	0.015	0.028	0.015	0.028
Vehicle Service year	-0.008***	0.003	-0.008***	0.003
Private vehicle Driving experience	0.006	0.005	0.006	0.005
Daily travel Practice	-0.0003	0.001	-0.0003	0.001
No. Year lived A.A.	-0.004**	0.002	-0.004**	0.002
Polln affects life	0.047	0.032	0.047	0.032
Rate Pollution	0.015	0.018	0.015	0.018
Cons	-1.546	1.502		

Source: Own survey data, 2020

**** Significant at 1%, ** Significant at 5%, * Significant at 10%*

In similar manner Table 4-11, explained that vehicle service year and number of years lived in Addis Ababa have negative impact at 1%, 5% significance level. While the other variables like level of education has a positive impact at 1% and 5%. In addition, as it was illustrated by Gupta (2016), MacFaddens's Pseudo R-square values show the level of improvement in the full model as compared to the intercept model, Accordingly, the Pseudo R2 of the analyzed data was 52.37%. The likelihood ratio for the models were -43.86589 and the prob>Chi2 is 0.000.

Level of education: The analysis result explicitly shows that as level of education increased, respondents are more likely willing to pay for air quality service improvement. As the level of educational status rises by 1%, the corresponding WTP will more likely increase by 7.4%. Similar studies show that private vehicle owners who have higher educational status can better understand the problem and found to be willing to pay for environmental service improvement. Previous studies like Desaigues (2011), reveals that people with higher educational status were more likely willing to pay for environmental service improvement.

Vehicle service year: The analysis comes out with private vehicle owners having long vehicle service year were less likely willing to pay for clean air service. Accordingly, the analysis shows that 1% rise in vehicle service year is more likely to decrease the WTP by 0 .85%. Previous similar study carried out by Dimitris (2007), in Canada focused to examine factors affecting households' choice for cleaner vehicles (recent manufactured). The final analysis result reveals that reduced monitory costs, tax relief and low emission rates encourages households to buy a cleaner vehicle. Contrarily people with long served vehicles

were imposing pressure to our environment, although does not have a relation to individual WTP.

Number of years lived in Addis Ababa: - This variable also results, as the respondents number of years lived in Addis Ababa has increased, they were less likely willing to pay for clean air service. Similarly, the analysis results that 1% increase with the number of years lived in Addis Ababa is more likely to decrease the WTP by 0 .39%. This implies that new comers to live in Addis were sensitive to air pollution problem since pollution emerges from internal effect (activities), so long lived residents may adapt to the situation.

4.3.1. Mean willingness to pay from the econometrics result

The model stated on sub-topic 3.9 of the previous section provides the necessary information on what variables are crucial for each of the responses to the WTP question. It also used to estimate the mean WTP. In this section the mean WTP of the respondents for air quality service improvement is stated on the above referred sub-topic. α and β were estimated by running normal probit and tobit model and the MWTP is analyzed using the best fit of tobit model using initial bid of 156 for the three equally divided surveyed groups. Hence, to draw the analysis the average of the negative coefficients of constant intercept by coefficient of the initial bid will give MWTP. Accordingly, the analysis result of the MWTP 17.10 ETB per month, which has a value of 205.22 ETB per year for a unit private vehicle owner.

Table 4-12: Estimation of Mean Willingness to Pay (MWTP)

	Coefficient	**Std. Error**	$-\alpha/\beta$	**P > |Z|**
Cons	-1.545842	1.501689		0.002
Initial bid	0.0903933	0.0341255	17.10	0.000

Source: Own survey data, 2020

4.3.2. Aggregate Willingness to pay for improved air quality services

In a final contingent valuation survey, an open ended questions was cited demanding what the respondents' maximum amount of money they are willing to pay for air quality service improvement. In the aggregation analysis collection of the entire willingness to pay of the total revenue at various price offer was taken in to consideration. Thus, the demand curve for the improved air quality services has also been derived.

According to the data obtained from Federal Transport Authority, the total number of private vehicle owners in Gullele sub city was 24,389. The combination of total vehicular population and the maximum amount of willingness to pay by private vehicle owners were used to produce aggregation of the whole willingness to pay.

Table 4-13 : Aggregate willingness to pay for air quality service improvement

Maximum WTP Interval	Center of WTP	No. of surveyed private vehicle owners	Surveyed Private vehicle owners (%)	Total No. of private vehicle owners	Total WTP of private vehicle owners'	Total Revenue
0-75	37.5	135	36.39	8875	332,812.5	332,812.5
76-150	112.5	112	30.19	7363	828,337.5	828,337.5
151-225	187.5	87	23.45	5719	1,072,312.5	1,072,312.5
226-300	263.5	37	9.97	2432	640,832.0	640,832.0

Source: Own survey data, 2020

The demand curve shown on Figure 4-4 shows number of people who were willing to pay and the amount which includes the initial bid value. About 23.45 % of respondents who were willing to pay has offered a close amount that fall in the interval which includes the initial bid amount (151 – 225 ETB).

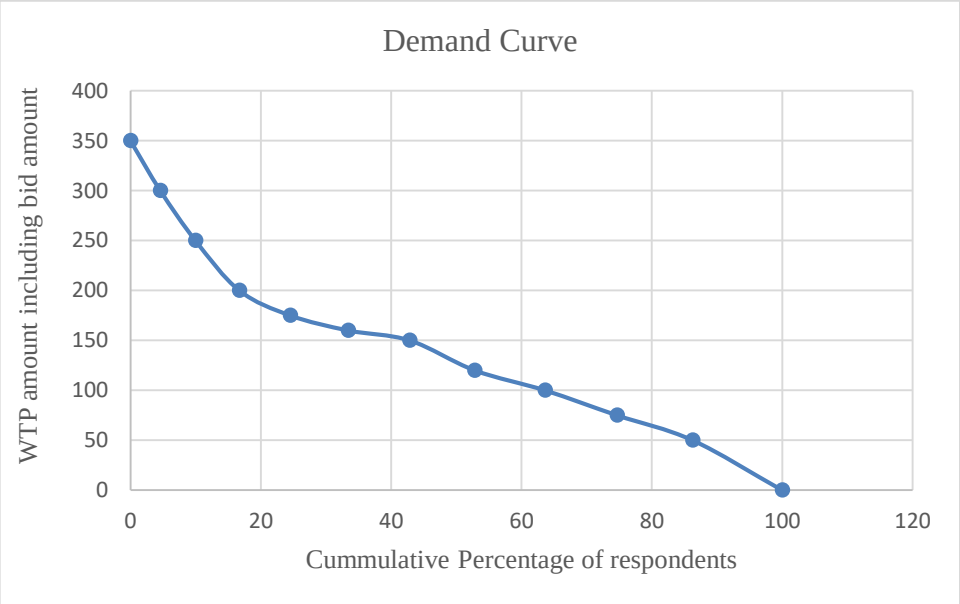

Figure 4-2 : The demand curve for reducing vehicular emission

Source : Own survey data and computation, 2020

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The main objective of the study was to investigate the willingness to pay of private vehicle owners' from their monthly income via a means of tax to establish a dedicated fund to cut vehicular emission in Addis Ababa by 30%.

The research tries to draw out air pollution in Addis Ababa is mainly caused by vehicular emissions, and the situation has prevailed in jeopardizing health condition of residents. Moreover, the tendency of air quality degradation in the study area have intensified due to the rise of vehicular population, vehicle service year and any other associated factors. So, it is found to be crucial and timely to carry out the study on the subject. Thus, during the course of the study, the survey instrument was prepared to collect both quantitative and qualitative evaluation of private vehicle owners found in the study area. In line with the pre-determined number of samples drawn from the population, adequate questionnaires were distributed and collected from the aforementioned respondents. At prior pre-test survey stage, an open ended Pretest survey was conducted on 50 (Fifty) randomly selected respondents to determine the initial bid amount. This enhance the researcher to fix the initial bid amount that they are willing to pay from their monthly income through tax for Addis Ababa Environmental Protection Agency to cut vehicular emission by 30%. The initial bid of the survey was 156 ETB. Taking upper and lower boundaries of the same 172 and 140 ETB respectively were determined for final survey, Hence, The final instrument was distributed using the above three discrete values in dichotomous questionnaires, the final result reveals that the majority of respondents 151 (36.7%) of the respondents were willing to pay an amount of 172 ETB.

The result entails that male respondents were dominant respondents having a value of 311 (75.5%) and have a significant effect on willingness to pay than female respondents. In addition, income, housing condition, level of education and vehicle service year restriction have also a significant on willingness to pay having a positive sign. This implies that respondents with higher income and educational status are more likely to pay than others for air quality service improvement in the study area. Among the various sources of air pollution, respondents believe that vehicular emission was the major source of air pollution in Addis Ababa. Further, the research again witnessed that the rise with the number of

vehicular population and the number of annual kilometers driven have an enormous effect in air quality degradation level, In supplement to the above argument vehicle service year has a significant effect on willingness to pay (WTP).

Following the rise of the problem through time, the majority of the respondents have a feeling that air pollution was affecting their life by inhibiting their breathing capacity/ difficulty in breathing/.

Having strong interest to curb the problem, private vehicle owners' were interested to participate in any action acting to lessen air pollution. On the other hand, majority of respondents were disagreed on the application of polluter pays principle. Nonetheless, they agreed on the application of vehicle service year restriction to cut the induced emission by 30%.

Finally, the probit and tobit regression analysis result on Table 4-5 shows that income and sex are statistically significant with positive sign. This infers that relatively higher educated male private vehicle owners were more likely willing to pay for air quality service improvement while marital status was statistically significant with negative sign. This infers married private vehicle owners were less likely to pay than single private vehicle owners.

In view of the above summarized discussion, this study on the subject was found crucial and timely as the problem rises up through time. Accordingly, this study helps to give an opportunity to meticulously review the existing policy and devise a mechanism to minimize the prevailing negative impact of the vehicular emission in Addis.

5.1.1. Gaps within the Policy

Addis Ababa is the most swiftly polluting city due to the existence of high number of vehicular population, economic activities and population growth. Accordingly, prompt counter measure has to be put in place to curb the problem. Hence, following the relevant policy review, the researcher has observed the under listed gaps to be addressed:

- On the policy, there is no clear presentation discussing about each pollution types separately. Proclamation No. 300/2002, comprises a bunch of ideas at a time, It discusses about pollution in general rather than to discuss each type of pollution separately E.g. Particle pollution, CO emission etc.
- The research has figured out that the rise in vehicular number, existence of old vehicles coupled with lack of proper maintenance and poor infrastructure development of our road infrastructure will play a significant role in emanating

vehicular pollution, So the policy will lack to discuss the role of cross-sectoral linkage for the purpose of emission reduction and implementation of the same.

- The policy has overlooked to address the polluter pays principle.
- The policy lacks to discuss about incentive mechanism used to promote in adopting technologically advanced equipment that can reduce the above discussed negative externalities.

5.2. Recommendations

- Promote the implementation of mass transport system (Public Transport), increase efficiency and modal integration system in order to make it preferable to discourage private vehicle owners which reduce the emission rate.
- Improve the infrastructure and promote carbon free transportation system, like walking, using bicycle.
- As it is practically resumed, Ministry of Transport should strictly keep on to implement restriction on the importation of used vehicles.
- The government should reinforce Environmental Protection Authority of Addis Ababa with all kind of support to improve its implementation capacity. This includes fining the amount determined by this research to improve the quality of air.

- Way forward: Agency should be determined to exercise its mandate by fining polluters. As it is scientifically supported by (Clark, Demers, Karr, & Koehoorn, 2010), increasing the surface coverage rate of land by planting trees can effectively reduce the concentration of air pollutants and help to purify air. In line with the above scientific evidence, GTP II promotes the ecological benefits by emphasizing forest development, even encouraging private sectors to take part. Thus, there should be robust determination in realizing the implementation of afforestation programs.

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