Addis Ababa University

College of Technology and Built Environment

School of Civil and Environmental Engineering

# Value of Travel Time for Commuter Work Trips in Addis Ababa, Ethiopia

By:

Kidanemariam Alula Habtegiorgis

A Thesis submitted for the partial fulfillment of the requirements of Degree of Master of Science in Road and Transport Engineering

Advisor: Dr. Fitsum Teklu, Co-Advisor: Dr. Abel Kebede

July, 2025

Addis Ababa, Ethiopia

**Addis Ababa University**

**College of Technology and Built Environment**

**School of Graduate Studies**

**School of Civil and Environmental Engineering**

# Value of Travel Time for Commuter Work Trips in Addis Ababa, Ethiopia

By:

Kidanemariam Alula Habtegiorgis

A Thesis Submitted to the School of Graduate Studies in Partial fulfilment of the requirements for the degree of Master of Science in Road and Transport Engineering

Approved by Board of Examiners

| | | |
|---|---|---|
| **Dr. Fitsum Teklu** | _______________ | _______________ |
| Advisor | Signature | Date |
| **Dr. Abel Kebede** | _______________ | _______________ |
| Co-Advisor | Signature | Date |
| **Dr. Ing. Robeam Solomon** | _______________ | _______________ |
| Internal Examiner | Signature | Date |
| **Dr. Yonas Minalu** | _______________ | _______________ |
| External Examiner | Signature | Date |
| **Dr.-Ing. Tensay Gebremedhin** | _______________ | _____________ |
| Chairperson | Signature | Date |

# Undertaking

I hereby attest that the research work entitled "Value of Travel Time for Passenger Transport of Commuter Work Trips in Addis Ababa, Ethiopia," is entirely original and has not been submitted to any other university for evaluation or credit toward a degree. It was completed under the guidance of my research advisor, Dr. Fitsum Teklu, and my co-advisor, Dr. Abel Kebede. Whenever content from other sources has been used, it has been appropriately cited and recognized.

*Kidanemariam Habtegiorgis*

Undertaker’s Full Name: Kidanemariam Alula Habtegiorgis

Place of Undertaking: College of Technology and Built Environment

Addis Ababa University,

Addis Ababa,

Ethiopia

Date: July, 2025

# Acknowledgement

I am profoundly grateful to my advisor, Dr. Fitsum Teklu, for his expert guidance and unwavering support throughout this research, and to my co-advisor, Dr. Abel Kebede, for his invaluable insights and encouragement. A special thanks to my examiner, Dr. Yonas Minalu and Dr. Robeam Solomon, for your valuable comments and constructive feedback during the defense.

I also want to thank my mentors, Dr. Marcelo Blumenfeld, Dr. Cassiano Isler, Dr. Namatirai Cheure, peers, and everyone else who stood by me; your encouragement and insight helped shape both my research and my perspective.

I extend my thanks to the College of Technology and Built Environment and the School of Civil and Environmental Engineering at Addis Ababa University for providing the academic environment and resources necessary for this study. Special appreciation goes to the supervisors and enumerators who assisted with data collection, as well as the 400 commuters who generously shared their time and experiences during the pilots and main surveys. Finally, I acknowledge the constructive feedback from my peer reviewers and the support of my family and friends, without whom this work would not have been possible.

Abstract

The economic valuation of travel time has been acknowledged as a core input to transport-demand modelling, infrastructure appraisal, and pricing strategies. In this study the Value of Time (VOT) of Addis Ababa commuters was estimated so that variations attributable to travel mode, socioeconomic profile,, and corridor congestion could be quantified during their morning trip to work. Data were collected through a stated-preference survey administered to 400 employed travelers in Addis Ababa. Six hypothetical choice tasks were completed by each respondent after a pilot instrument had been refined. Utilities were modelled by multinomial specifications, and supplementary regressions were performed to test income-, purpose- and congestion-interaction effects. the study finds an aggregate VOT of 259.6 Birr/hour in the pilot and 275 Birr/hour in the main survey lower than GDP-scaled benchmarks and indicating a high premium on time savings. Heterogeneity analysis reveals that individuals from higher-income households and private-mode users exhibit substantially higher VOTs. The study recommends differentiated pricing strategies. Future research should enlarge the sample well beyond the current cases and extend the survey to multiple journey purposes with an addition of attributes such as impact of activities during travelling and urgency. These enhancements will generate purpose- and reliability-sensitive VOT estimates that more accurately reflect Ethiopia's diverse travel behaviour.

***Key words***: VOT, Stated Preference Survey, Transportation, Discrete Choice Modeling, Addis Ababa.

# Table of Contents

# List of Figures

# List of Tables

# Acronyms

| | |
|---|---|
| AACAPDC | Addis Ababa City Administration Plan & Development Commission |
| CBA | Cost Benefit Analysis |
| ESS | Ethiopian Statistical Services |
| LRT | Light Rail Transit |
| OLS | Ordinary Least Square |
| PT | Public Transportation |
| PrT | Private Transportation |
| RP | Revealed Preference |
| SP | Stated Preference |
| TC | Travel Cost |
| TT | Travel Time |
| VOT | Value of Travel Time/Value of Time/Value of Travel Time Savings |
| WTP | Willingness to Pay |

# 1. Introduction

## 1.1 Background information

Time is a resource universally shared by humanity, yet the manner in which we allocate our 24 hours a day is profoundly subjective. This variance in behavior can be attributed to the diverse aspirations and desires that drive individuals in their pursuit of a fulfilling life. Consequently, people make choices on how to invest their time based on what they perceive as valuable to them, giving rise to a complex web of economic, psychological, and social repercussions. In order to dissect the economic implications of these choices, the concept of "value of time"[VOT] emerges as a pivotal point of examination.

In the realm of transport economics, it denotes the opportunity cost of the time a traveler spends on their journey. Essentially, it quantifies the amount a traveler would be willing to pay to save time or the compensation they would accept for time lost. The pivotal role of this concept is evident in justifying transport improvements, as they directly impact the time savings for travelers (Wardman, 1998).

The VOT holds multifaceted significance across various domains, prominently within demand forecasting and economic appraisal. In demand forecasting, understanding the value of time is critical for assessing how consumers make choices about when, where, and how they travel. This knowledge enables transportation planners to predict demand patterns and prioritize infrastructure investments. By incorporating the VOT into demand models, analysts can anticipate shifts in travel behavior, assess the impact of pricing policies, and make informed decisions to alleviate congestion and enhance transportation efficiency. It also aids in resource allocation, ensuring that investments are directed towards projects that offer the most substantial time savings, thereby maximizing societal benefits (Wardman & Lyons, 2016).

In the realm of economic appraisal, the VOT is pivotal when evaluating the cost-effectiveness of transportation projects. It serves as a key metric in cost-benefit analysis, allowing decision-makers to quantify the potential benefits in terms of time saved. Whether it involves road construction, public transit expansion, or airport improvements, the VOT plays an indispensable role in justifying these investments (Gwilliam, 1997). It helps assess whether the gains in travel time saved outweigh the costs of the project, thereby guiding policymakers in selecting projects that generate the most significant economic and social returns.

The VOT exhibits variations across a spectrum of categories. It differs significantly by gender, with studies suggesting that women often place higher value on travel time savings due to their multiple roles, including work, caregiving, and household responsibilities (Ng & Acker, 2018). Moreover, according to Small, K. A. (2014), income levels influence one's perception of time value; higher-income individuals may place a premium on their time due to higher opportunity costs associated with lost work or leisure hours. Educational background also plays a role; those with advanced education may have more flexible work arrangements, affecting their time valuation (Dingil & Esztergár-Kiss, 2021).

The mode of transportation is a significant factor affecting the VOT. Commuters using public transit systems often have lower values of time compared to those using personal vehicles, as the former can be more productive during travel or experience lower out-of-pocket costs (Jang & Ko, 2019). Journey purpose also matters, as business travelers might place a higher value on time savings due to work-related pressures, whereas leisure travelers may be more relaxed with their time which we expect a lower VOT. Recognizing these variations across different categories is crucial, as it provides a rationale for tailoring transportation policies and infrastructure investments to better meet the diverse needs and preferences of the population (de Jong & Kouwenhoven, 2020).

The study of the value of time in passenger transport is not merely an academic pursuit; it is a pressing practical necessity in today's dynamic and interconnected world. As urbanization accelerates and transportation systems continue to evolve, there is a growing imperative to comprehend the intricacies of individuals' time preferences in travel (Beesley, 1965). Failure to do so can result in suboptimal transportation policies, resource allocation, and infrastructure development. By delving into the value of time, we gain valuable insights into the intricate trade-offs individuals make daily, and this knowledge equips us to design more efficient, equitable, and sustainable passenger transport systems. This research is essential for policymakers, urban planners, and economists seeking to address congestion, reduce environmental impacts, and enhance the overall quality of life for the communities they serve.

Studying the value of time for work-related trips in Addis Ababa City is crucial for several reasons. Addis Ababa, as Ethiopia's political and economic hub, presents unique travel characteristics such as highly congested corridors, a predominance of public transport modes, and rapidly growing commuter demand that can dramatically amplify the time costs borne by workers. First and foremost, work-related travel often constitutes a significant portion of daily commuting patterns, directly impacting the productivity and well-being of the city's workforce. Understanding the value of time for these trips is essential for urban planners and policymakers to prioritize transportation infrastructure investments that are tailored to local needs. Moreover, Addis Ababa's specific socio-economic profile ranging from government employees in public offices to informal-sector workers means that value-of-time estimates derived from other contexts cannot be directly transferred without risking misallocation of resources.

Assessing the time spent on work-related travel also provides valuable insights into the broader economic implications of commuting, influencing decisions related to public transportation funding, congestion-mitigation policies, and quality-of-life improvements for residents. Despite its clear importance, the topic of VOT remains largely understudied in the Ethiopian context: only a handful of studies have reported VOT estimates and then only as a byproduct of other analyses or limited to specific sectors such as public offices. This gap in the literature underscores the need for a focused investigation of work-related value of time in Addis Ababa City. By concentrating explicitly on commuter trips for employment purposes, this study aims to fill that void and deliver context-sensitive insights with far-reaching implications for both individuals and the city's sustainable development.

## 1.2 Statement of Problem

The value of travel time (VOT) is a cornerstone parameter in transport demand modelling, economic appraisal, and project evaluation; yet, in Ethiopia it has received remarkably little sustained scholarly attention. The few available studies are both narrow in scope and somewhat dated: Weldegiorgis (2007) reported VOT only incidentally as a by-product of a logit model where the method used to develop the is not clearly not stated, while Wondimu (2016) examined time valuation for administrative services rather than passenger transport. Because these works are now more than a decade old and do not explore how VOT varies across income, gender, or travel-purpose segments, policy makers still lack reliable, up-to-date evidence for forecasting demand or assessing the welfare impacts of transport investments.

## 1.3 Research objectives

### 1.3.1 General Objective

The overarching objective of this research is to estimate the value of travel time in morning commute trips within the context of Addis Ababa City, Ethiopia. This research aims to provide a detailed understanding of how individuals living in the city perceive the value of their time and how it influences their travel decisions. Thus, it provides an input to transport planners and decision makers in comparing potential solutions in solving the transportation related problems.

### 1.3.2 Specific objectives

1) Assess the value of travel time (VOT) in morning commute trips within the context of Addis Ababa City.
2) Explore variations in VOT across different spatial and socio-demographic categories, including income levels, gender, educational backgrounds, distance from work to home and others to uncover the factors that influence time valuation in work-related trips.

### 1.3.3 Research Questions

- What is the VOT in morning commuter trips across Addis Ababa City?
- What is the key socio-demographic factors, such as income levels, gender, and educational backgrounds, that contribute to variations in VOT among working individuals in Addis Ababa City?
- What are the implications of the perceived VOT for transportation demand forecasting and the economic appraisal of transportation projects in the broader urban setting of Addis Ababa City?

## 1.4 Scope and Limitations

The thesis investigates the value of travel time for morning commuter trips for workers in the city of Addis Ababa, Ethiopia. The primary limitation of this research lies in the use of stated preference (SP) data rather than revealed preference (RP) data. Stated Preference (SP) surveys offer a powerful way to capture how travelers trade off hypothetical alternatives, but have some drawbacks. Hypothetical bias can lead people to overstate what they would pay or choose options they might not in real life since there are no real consequences for their answers. Complex tasks with many attributes can overwhelm respondents and prompt them to ignore some details. Framing effects or unrealistic attribute ranges can skew results. Poor sample representativeness or strategic misreporting also makes it hard to apply SP findings to real-world contexts. These limitations are well documented in the discrete choice modelling literature (e.g. Hensher, Rose, & Greene, 2005).

A significant constraint of this study was the limited resources available to conduct the research. Similar studies are often conducted on a larger scale, such as at the municipality, city, or regional level. Even though this research has been conducted on a city level, due to budgetary and time limitations, this research is confined to a smaller representative scale. Despite these constraints, the study aims to shed light on the topic and provide valuable insights.

## 1.5 Significance and Impact of the research

This research holds significant potential to transform transportation management, policy development, and economic appraisal in Addis Ababa City. By assessing the value of travel time (VOT) for morning work commuter trips, the study provides crucial insights into how individuals perceive the economic worth of their time during travel. These insights can aid policymakers, urban planners, and transportation authorities in designing more efficient systems to reduce congestion and enhance mobility, ultimately improving the quality of life for commuters.

Moreover, the study highlights variations in VOT across socio-demographic categories such as income, gender, and education. These findings can guide the creation of equitable transportation policies and pricing strategies tailored to the diverse needs of the population. Such targeted approaches ensure that infrastructure investments address the specific requirements of different groups, fostering inclusivity and accessibility.

Additionally, this research contributes to economic appraisal by providing a foundation for cost-benefit analyses of transportation projects. Accurate estimations of the economic benefits of time savings can help decision-makers prioritize projects that maximize societal welfare and deliver measurable economic returns. By testing on collected a dataset and analysis focused on work-related trips, the study also encourages future research and evidence-based policymaking in transportation management and urban development, ensuring its lasting impact on the region.

## 1.6 Ethical Considerations

The study adhered to ethical research guidelines to ensure participants' privacy and informed consent. Key ethical measures included:

- Voluntary participation: Respondents were informed of their right to withdraw at any time.
- Anonymity and confidentiality: No personal identifiers were collected, and data was securely stored.

## 1.7 Outline of the Thesis

The following chapters of the research paper develop basic concepts and methods of assessment of value of travel time using stated preference survey.

- Chapter 2: Literature Review
- Chapter 3: Methodology
- Chapter 4: Results and Discussion
- Chapter 5: Conclusion and Recommendations

# 2. Literature Review

## 2.1 Introduction

Value of Travel Time (VOT) is a fundamental concept in transport economics that influences human behavior in decisions making made by travelers such as mode choice, route choice as well as governing agencies that are involved in a policy-making and infrastructure planning. VOT is the time-money trade-off that travelers are willing to make in exchange for saving travel time. VOT is particularly relevant to commuter travel since it has immediate implications for travel behavior, congestion management, and economic evaluation of transport projects.

This section of the thesis covers a range of topics, including basic concepts of VOT, explanatory variables of VOT, various approaches to estimate VOT and their weaknesses and strengths, alternative approaches to designing SP survey and its analysis. Finally, the section presents an empirical overview and conceptual framework, which is being utilized as the basis of the research design and methodology of this research.

## 2.2 Basic Concepts of Value of Travel Time (VOT)

The scientific literature expresses the worth of time as a quantitative monetary variable. Researchers employ various types of estimates in their investigations, including Value of Time (Rouwendal 2003), *Subjective Value of Time* (Armstrong et al. 2001), and *Social Price of Time* (Mackie et al. 2001). Furthermore, when discussing the value of travel time, one additional variable emerges: the value of travel time savings (VTTS; see Gunn 2001). Given that each of these variables is used to assign a monetary value to a single time unit, there are no significant distinctions between them (Zamparini & Reggiani, 2007a). Using one expression over another is determined by the underlying study's goal where this study used the term VOT to indicate the worth of time.

The concept of VOT has been widely used in transport research, dating back to the initial economic principles of connecting travel time with opportunity cost (Beesley, 1965). The Value of Time (VOT) refers to the monetary worth individuals assign to their time, commonly expressed as a rate (e.g., Birr/hr or $/hr). It reflects a person's willingness to trade money for time, especially in the context of travel (Small & Verhoef, 2007).

The Value of Travel Time Savings (VTTS) is closely related and often used interchangeably, but more specifically refers to the benefits accrued by reducing travel time, such as through faster routes, reduced congestion, or improved public transport services (Wardman,1988). In practice, VTTS is the applied form of VOT in transport project appraisal and cost-benefit analysis (Mackie et al., 2001).

The difference is mostly terminological and contextual: VOT is the underlying concept, while VTTS is the expression of this concept in evaluating travel time reductions. As Hensher (2001) notes, VTTS is "the major contributor to user benefits in most transport infrastructure evaluations," and reflects how the value of time is realized in measurable transport outcomes.

VOT is argued to differ by income, trip purpose, and choice mode, based on theoretical models, and would influence transport policy making and charging systems (Small, 2014). An understanding of these terminologies would be required when designing transportation systems and assessing cost-benefits.

Any situation where there is a difference in travel-time and money cost between choices, and enough people can be observed making choices between the alternatives is a potential source of evidence for estimating the rate of exchange of travel time and money, VTTS, either as an average over the group or as set a vector of values for subgroups or as distribution across the travellers. One approach involves postulating a causal model of choice behaviour in which it is supposed that differences in travel time and in costs between the different travel alternatives have some influence on relative attractiveness (Gunn, 2008).

A mathematical model of this relative attractiveness is needed. The simplest model (and one that is often used) is to characterize the relative attractiveness of two alternatives **ΔU** in terms of differences in travel time **ΔT** and in cost **ΔC**, including differences in the unknown **ΔE**, as a linear regression

$$\Delta U = \beta_1 . \Delta T + \beta_2 . \Delta C + \Delta E \quad (1)$$

where both $\beta_1$& $\beta_2$ are coefficients with negative values because increasing either the cost or time decreases attractiveness (utility).

The following can now be observed: increasing **ΔT** by one unit of time reduces **ΔU** by $\beta_1$, which is exactly the effect of an increase in C by —$\beta_2$ units. Thus, one unit of time is worth $\beta_1/\beta_2$ cost units, so we may say that $\beta_1/\beta_2$ is known as VOT.

This simple example illustrates the basic process. Because we have the time and cost vales for the alternatives we could estimate the difference between these vales. This concept will more explained later on when we discuss the design of survey. It is reasonably evident how to measure the differences in travel time and travel cost, but differences in "everything else" are somewhat trickier. To be covered under this heading are non-time-related differences in the attractiveness of travel and the differences in behaviour (and satisfaction gained) resulting from the different time and money budgets left after the trip (Gunn, 2008).

In practice this problem is almost always avoided. Where the two alternatives are considered to be essentially the same except with respect to time and cost, the usual assumption is that E is simply an error term distributed around 0, with a distribution that will remain fixed in the future. The neglect of the wider economic picture is justified on the grounds that the variations in travel times and cost will be small in comparison to the total time and money budgets, and that no "readjustment" to behaviour will occur. Usually this would be assumed, for example, of the choice between two alternative routes to a destination, where road quality, scenic beauty, density of traffic, etc., are similar. Where the two alternatives might be thought to be qualitatively different; ΔE is usually simply assumed to be an unknown influence for each traveler, varying from traveler to traveler. This is generally the case in choices between different travel modes (e.g., train vs. bus).

## 2.3 Explanatory Variables of VOT

Value of Travel Time is influenced by various factors, which, in turn, shape the travel behavior and decision-making processes of individuals. The significant socioeconomic attributes on which a person's willingness to pay to save time is based include income, gender, and employment status. Trip characteristics such as mode of travel, trip purpose, and time of day also influence the perceived value of travel time savings. External factors such as congestion levels, transportation infrastructure, and emerging technologies further modify VOT through changes in the travel experience and available alternatives. Understanding these explanatory variables is crucial for accurately estimating VOT and designing transportation policies that reflect diverse traveler preferences and behaviors.

According to the recent meta-analysis by Wardman et al. (2023), travel time valuations may vary depending on several conditions, including:

- Work trip or Non-work trip.
  - For non-work trips, this includes the following:
    - Purpose of the journey (commute, leisure, etc..)
    - Traveler income
    - Socio-economic characteristics
    - Journey length
    - Travel conditions (presence of congestion)
- Available modes
- Type of transport (Private Car vs Public )

The most basic division is that between travel for work and non-work purposes. A practical implication of this is that travel demand data should distinguish between these journey categories. However, this study concentrates on work trips.

### 2.3.1 Socioeconomic Factors

A number of socio-economic factors, such as income level, gender, and employment status, could influence the VOT. Time of higher-income people can have higher value of time due to the increased opportunity cost of their time (Wardman, 1998). Gender could also influences VOT due to the fact that there is a difference in the perception of time savings between men and women, given the way their activities are framed in domestic and professional functioning (Prayag et al., 2015; Smith & Ding, 2012). Moreover, life stage and occupation will affect VOT, as the time valuation thresholds for students, retirees, and full-time workers may be different.

### 2.3.2 Trip Characteristics

The VOT varies according to the purpose of the trip, travel distance, and mode of transport. During peak hours, commuters usually value time higher compared to leisure travelers. People who are travelling for leisure may show greater flexibility in the valuation of their time (De Jong &

Kouwenhoven, 2020). The mode of transport also plays an important role; for example, VOT tends to be higher for car users than for public transit users, partly because of differences in comfort, reliability, and perceived control over travel.

### 2.3.3 Network and Environmental Factors

Traffic congestion, urbanization, and especially transportation infrastructure make a significant impact on VOT. In more congested cities, the cost of delay will be bigger, leading to a higher VOT (Razavi & Titheridge, 2020). They argue that when traffic congestion intensifies, each minute spent on the road imposes substantially greater discomfort, stress and unpredictability passengers face cramped, stop-start conditions, higher risks of lateness and virtually no chance to work or relax in-vehicle. As a result, the "pain" of delay per minute grows, so travellers become willing to pay more to avoid even small-time losses; in other words, the value of saving a minute of travel time rises in line with the heightened disutility and opportunity costs that congestion imposes.

Furthermore, it has been shown that multimodal transportation options and significant investments in infrastructure, such as high-speed rail and metro systems, have an impact on the valuation of time by travelers (Vickerman, 2006).

### 2.3.4 Technological and Behavioral Influences

Digital technology development, work-from-home, and changing travel behaviors have reshaped VOT. With the evolution of remote working and flexible scheduling, traditional patterns of commuting are now changing, and this in turn is changing the way people value their travel time (Wardman & Lyons, 2016). Similarly, connectivity through mobile enables travelers to spend time on either productive or enjoyable activities while commuting, which reduces perceived VOT.

## 2.4 Approaches to Estimating VOT and Their Strengths & Weaknesses

Regression analysis is the fundamental statistical method for estimating linear estimates of estimated coefficients with the dependent variable. It estimates how a dependent variable is influenced by a collection of explanatory factors, often known as independent variables or covariates. Ordinary Least Square Method (OLS) is the most commonly used type of regression analysis. In transportation analysis, however, we are often interested in individual choice within a defined option set, i.e. accessible choice opportunities. The dependent variable is then a choice indicator, so OLS is not a suitable statistical model. Instead, nonlinear discrete choice models like logit or probit must be used (Wardman & Toner, 2018).

The discrete choice approach for estimating VOT is largely based on a random utility (RU) framework. McFadden (1974) was the first to suggest this approach, and it has subsequently become standard practice in transportation choice analysis. The RU model can be appropriately extended to an indirect utility function using trip cost and travel duration as parameters. The indirect utility function can then be reliably approximated using a discrete choice model.

Different approaches have been developed to estimate VOT, all of which have their strengths and weaknesses. RP approaches infer the VOT from observed travel behavior, reflecting actual trade-offs in the real world between time and cost. In most cases, these methods will be constrained by existing market conditions and may lack sufficient variability in travel choices. While RP methods rely on actual data from on-road choice situations, SP methods rely on hypothetical scenarios in an attempt to elicit travelers' willingness to pay for time savings and, hence, enjoy more freedom in experimental design but with the risk of introducing biases. Hybrid models combining RP and SP data, advanced analytical techniques using machine learning and big data, have recently emerged. Each of these estimation approaches calls for complete comprehension to select the appropriate method for VOT evaluation in different scenarios.

### 2.4.1 Revealed Preference (RP) Approaches

RP methods deduce VOT from actual travel behavior, observing mode choices or route selection or time/cost trade-off (Beesley, 1965). The wage rate approach assumes that individuals equate time savings with their hourly earnings. While RP methods are preferred because of real-world data and no hypothetical bias, they are liable to limitations associated with natural variations in travel behavior and exogenous validating factors.

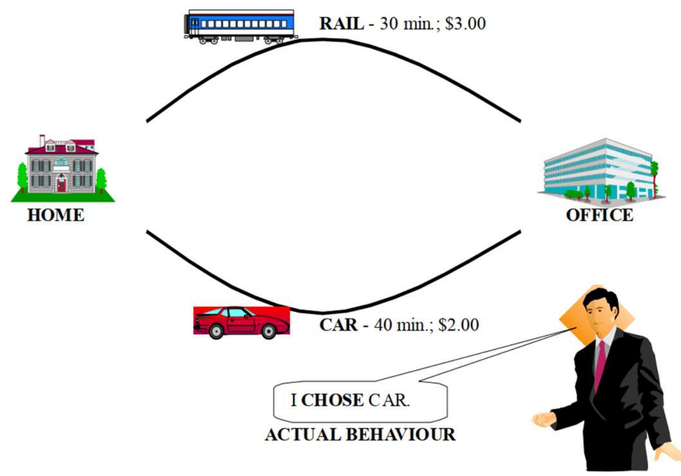



**Figure 1. Revealed Preference (RP) Example (Adopted from Sanko, 2001)**

### 2.4.2 Stated Preference (SP) Approaches

SP methods are based on survey-based hypothetical scenarios that require respondents to choose between alternatives with different time and cost trade-offs. These methods allow a researcher to capture, approximately, those varieties of conditions and preferences beyond the reach of RP data (De Jong & Kouwenhoven, 2020). However, SP studies are generally afflicted by strategic response biases or cognitive burdens for participants.

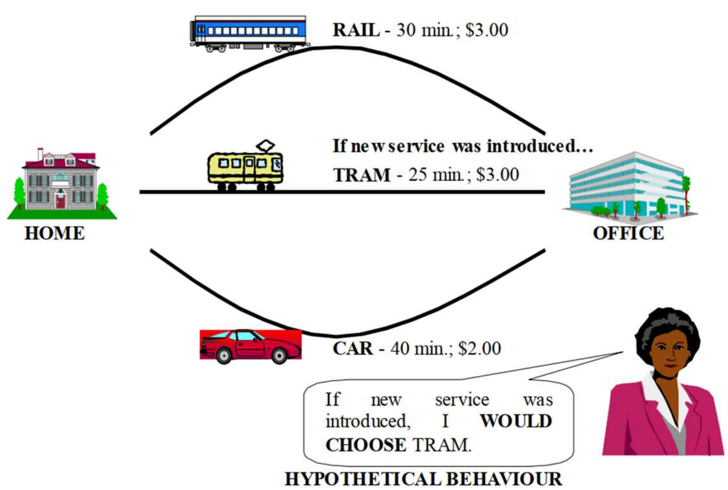



**Figure 2.** Stated Preference (SP) Example (Adopted from Sanko, 2001)

Figure 2 illustrates respondents' selections among the current transport options, whereas Figure 3 depicts their choices when the new TRAM service is included.

**Table 1. Comparison between RP and SP Data (Adopted from Sanko, 2001)**

| | RP Data | SP Data |
|---|---|---|
| **Preference Information** | • Result of a real behavior<br>• Consistent with behavior of existing situation<br>• Extract choice result | • Hypothetical situation expression<br>• Possibility of inconsistent with the behavior of existing situation<br>• Extract ranking, rating, choice result, etc |
| **Alternatives** | Existing alternatives | Existing and non-existing alternatives |
| **Attributes** | • Measurement error<br>• Limited ranges of attribute level<br>• Presence of collinearity among attributes | • No measurement error<br>• Extensibility of the range of attribute levels<br>• Controllability of the collinearity among attributes |
| **Choice Set** | Not clear | Clear |
| **Number of Response(s)** | One response per respondent | Multiple responses per respondent |

### 2.4.3 Hybrid Models and Advanced Methods

More recently, the estimation accuracy is being enhanced through combinations of RP and SP approaches (Hensher, 2018). Big data analytics and machine learning also increasingly provide enhancements to the estimates of VOT by incorporating more complex patterns of behavior. For example, some models are designed to allow travel time reliability in recognition of not all time savings being equally valued (De Palma et al., 2010).

## 2.5 Alternative Approaches to Designing SP Surveys and Their Analysis

SP surveys are perhaps the most commonly used method of estimating VOT, but their success depends upon sound survey design and analytical techniques. In designing SP surveys, a key task is to construct choice scenarios that represent actual trade-offs related to travel time, cost, and other attributes in a manner that elicits a meaningful response from the respondent. All factors affecting response quality involve question framing, the number of alternatives, and attribute realism. After the data collection is conducted, there are several econometric models analyzing the responses through various methods like multinomial logit, mixed logit, and latent class models, allowing the consideration of preference heterogeneity and choice behavior. More recently, recent improvements in estimation, such as adaptive surveys and machine learning-based analysis, further increased the precision of SP-based VOT estimates and enhanced their usability in transport studies (Aboutaleb et al., 2021).

### 2.5.1 Survey Design Considerations

Framing effects and respondent involvement are major factors affecting responses; interactive and adaptive questionnaires enhance data quality. In a choice experiment, also known as a stated choice survey or a choice-based conjoint, the analyst asks agents (i.e., decision-makers, such as consumers purchasing a specific type of product, travelers taking a trip, patients selecting treatment, physicians prescribing medication, and so on) to complete a series of choice tasks (also known as choice sets) that include several alternatives, each described by their characteristics. Demonstrate examples of choice tasks are adopted from (Bliemer & Rose, 2024).

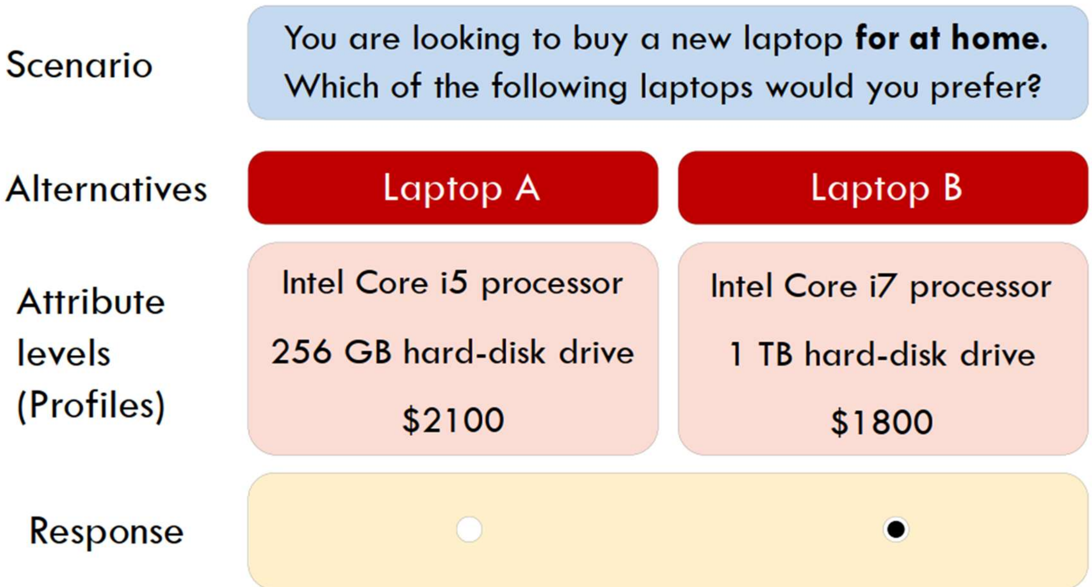



**Figure 3. Laptop Choice (Adopted from Bliemer & Rose, 2024).**

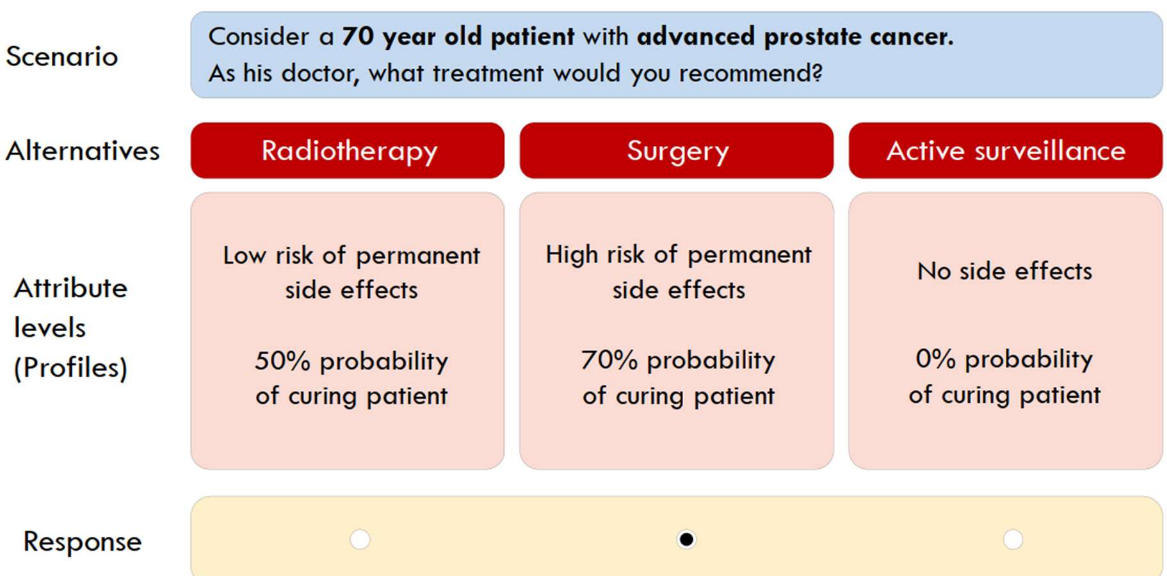



**Figure 4. Treatment Choice(Adopted from Bliemer & Rose, 2024).**

Choice experiments are typically part of a bigger questionnaire or survey that consists of multiple sections. Although survey flow varies each questionnaire, the first section of a survey usually includes agents being asked screen-out questions to determine their eligibility. In the second portion, agents may be asked questions about their current status and behavior in relation to the specific study. This information can be utilized to tailor choice tasks in the third section, which includes the choice experiment. The fourth section often closes with additional questions, such as general views and perceptions, socio-demographic questions, and open-ended qualitative inquiries. While socio-demographic questions may be asked earlier in the survey, attitudinal questions (level of comfort, reliability etc..) should be asked after the choice experiment to avoid affecting choice behaviour (Bliemer & Rose, 2024).

Choice experiments can be difficult to design since they include multiple phases or stages (Bliemer & Rose, 2024). Designing a choice experiment typically involves the following steps:

i. Determine experiment labeling based on research questions.

ii. Select experiment alternatives and attributes.

iii. Codify attribute levels.

iv. Set number of choice tasks in experimental design.

v. Select an experimental design strategy.

vi. Pilot study;

vii. Main study.

In stated-preference surveys, researchers can elicit preferences using one of four primary response formats: the rating format, in which respondents assign each alternative a numerical score (e.g., 1–10) to indicate preference intensity; the ranking format, where alternatives are ordered from most to least preferred to yield ordinal data; the degree-of-preference (constant-sum) format, which asks respondents to distribute a fixed number of points (e.g., 100) across alternatives to capture relative strength of preference; and the choice-experiment (discrete-choice) format, wherein respondents select their single most-preferred option from each set, thereby generating data suitable for logit-based utility estimation (Louviere et al., 2010).

**Step 1: Labelled versus Unlabelled experiment**

Whether a labelled or unlabelled experiment is suitable for a certain study depends on the research questions being addressed. If one is interested in determining the willingness-to-pay (WTP) for certain attribute levels, or in deA label can be for example a category of a product, a brand name but might also refer to an alternative's specific type - such as Status or no Choice alternative. Then again, All alternatives possessing one and the same label will cancel out any hypothetical role in this choice process attributed to a particular label. An example is shown in Figure 1 whether the brand of the laptop choice was omitted (Laptop1, Laptop 2). Such an experiment is often referred to as an unlabelled experiment.

Whether a labelled or unlabelled experiment is suitable for a certain study depends on the research questions being addressed. If one is interested in eliciting WTP for given attribute levels, or the relative importance of attributes in decision-making, then it often suffices to consider an unlabelled experiment in which two or more alternatives are shown as variants of the same label. If on the other hand one wants to know market shares of a product type or their elasticities then a labelled experiment is appropriate. If one wants to predict the unconditional absolute demand in the market using unforced choice tasks, then one would include an opt-out alternative whereas it can be left out if one is only interested in relative market shares or conditional demand across products by asking to make a forced choice-it is worthwhile noting that evidence suggests that across forced and unforced choice tasks the results one gets for the same empirical context can vary dramatically (see Dhar and Simonson, 2003).

A status quo alternative is often added to determine willingness to deviate from an existing policy or simply to make the choice task look more familiar to agents. Labelled experiments can also be used to determine WTP values, particularly if the WTP values are expected to vary across different labelled alternatives (e.g., the willingness to pay for travel time savings differs for bus and car use). But if, alternatively, WTP values are expected to be the same across alternatives, then because labelled experiments generally involve more complex choice tasks and the estimation of a greater number of coefficients, there is little reason to conduct a labelled experiment if the purpose of the study is solely the determination of WTP values of attribute's relative importance in decision-making, then it often suffices to consider an unlabelled experiment in which two or more alternatives are shown as variants of the same label.

On the other hand, a labelled experiment is suitable if one would like to determine market shares of a product type or demand elasticities. One would include an opt-out alternative if one is interested in predicting the unconditional absolute demand in the market using unforced choice tasks, while it can be left out if one is only interested in relative market shares or conditional demand across products by asking to make a forced choice (it is worthwhile noting that evidence suggests that for the same empirical context, the results one obtains from forced and unforced choice tasks can vary dramatically; see Dhar and Simonson, 2003). A status quo alternative is often added to determine willingness to deviate from an existing policy or simply to make the choice task look more familiar to agents. Labelled experiments can also be used to determine WTP values, particularly if the WTP values are expected to vary across different labelled alternatives (e.g., the willingness to pay for travel time savings differs for bus and car use). If however, WTP values are expected to be the same across alternatives, then given that labelled experiments generally require more complex choice tasks and the estimation of a larger number of coefficients, there is no reason to use a labelled experiment if the sole purpose of the study is to determine WTP values.

**Step 2: Determine alternatives and attributes**

Once the study objectives have been established and a labelled or unlabelled experiment has been selected, the analyst must decide which options and qualities to include in the choice experiment. This varies per study, and while identifying the options and qualities is simple in some, it requires careful consideration of how the results will be used in others (Sanko, 2001).

### 2.5.2 Analytical Techniques

SP data are analyzed using, among others, multinomial logit (MNL), mixed logit (ML), nested logit (ML) and latent class models (Train, 2009). These models capture preference heterogeneity at the individual level and the variation of VOT across the population's various segments. Machine learning techniques are also being explored to complement these traditional statistical methods in the estimation of VOT.

Among these, the logit-based models, including the MNL and NL, have enjoyed widespread application mainly because of their tractability and closed-form solutions (Ben-Akiva & Lerman, 1985). However, such models enforce the IIA property that may not be proper in most real-world decision-making scenarios. This has led to a surge in prominence of mixed logit models, as stated by Train (2009), that permit random taste variation, unrestricted patterns of substitution, and correlation in unobserved factors. For example, imagine we're modelling a commuter's choice among driving, taking the bus, or boarding the train. In a mixed logit framework, we might assume that the time-sensitivity coefficient ($\beta_{time}$) is not fixed but follows a normal distribution across individuals so one commuter may be very time-averse ($\beta_{time} \approx -0.10$) while another is less so ($\beta_{time} \approx -0.05$). This captures **random taste variation**. Because $\beta_{time}$ and the cost coefficient $\beta_{cost}$ can be drawn jointly, we allow for **correlation in unobserved factors** for instance, someone who dislikes delay may also be more cost-sensitive. Finally, by integrating over the distribution of these random coefficients rather than imposing a particular substitution structure (as in nested or multinomial logit), we permit **unrestricted patterns of substitution**: if bus travel becomes faster, some commuters may switch heavily to it, while others hardly change, without being constrained by a fixed cross-elasticity formula (Train, 2009). This flexibility both reflects real heterogeneity in preferences and avoids the rigid substitution patterns of standard logit.

Alternatively, one can employ Probit models, which relax the IIA assumption by allowing the unobserved utility terms to follow a (multivariate) normal distribution and thus to be correlated across alternatives. Often, their computing complexity has substantially hampered wide application. Still, more developments of machine-learning-assisted improvements in choice models have been undertaken in the past two decades but again call for behavioral interpretability if applied aptly to problems within transport economics (Rahnasto & Hollestelle, 2024).

VOT estimates are usually based on RP and SP data. RP data reflect actual choices but are often contaminated by external factors, including habitual behavior and market constraints. SP data, however, can be presented in a controlled hypothetical scenario where trade-offs between travel time and cost can be explicitly measured. Hybrid modeling approaches that combine RP and SP data yield more robust estimates of VOT, leveraging their respective strengths (Louviere et al., 2000).

A useful starting point for latent class models is Greene and Hensher's work, which shows how a finite mixture of taste segments can uncover groups with distinct value-of-time distributions tied to socio-economic or trip-purpose characteristics (e.g., commuters vs. leisure travellers) (Greene & Hensher, 2003). Boxall and Adamowicz (2002) apply a similar approach in a SP context to demonstrate how psychological attitudes (e.g. environmental concern) map onto class membership and thus influence marginal willingness-to-pay. For hierarchical Bayesian methods, Train (2009) provides a clear exposition of how fully individual-specific coefficient estimates can be recovered by combining prior distributions with observed choice data, allowing VOT to vary continuously with observed covariates (e.g. income, trip purpose) and latent traits.

This often includes sensitivity analyses and robustness checks to validate model estimates, including cross-validation techniques, bootstrapping, and out-of-sample predictive tests. Several contextual factors, such as congestion levels, travel reliability, and multimodal interactions, have also been identified in the literature as important in refining VOT estimates within probabilistic choice frameworks.

## 2.6 VOT in Ethiopia

VOT has been extensively studied in a range of international settings (Abrantes & Wardman, 2011; Shires & de Jong, 2009; Wardman et al., 2023; Zamparini & Reggiani, 2007b). However, there remains a clear gap in its examination within the Ethiopian context. A pioneering study by Wondimu (2016) assessed VOT for journeys to public offices, revealing the economic value that Ethiopian professionals place on their time. Moreover, a handful of researchers have derived VOT as a by-product of discrete choice model estimations, but comprehensive analyses of travel-time valuation in Ethiopia's passenger transport sector are still lacking.

**Table 2. Summary of Discrete Choice Models conducted in Addis Ababa City.**

| Researcher | Measured | Reference | $\beta_T$ | $\beta_C$ | VOT (Birr/min) | VOT (Birr/hr) |
|---|---|---|---|---|---|---|
| Gebeyehu, M., & Takano, S. (2007) | Bus | Taxi | -0.0097 | -0.002 | 4.85 | 291.00 |
| Teshome, M. (2007) | Base Model | Taxi | -0.0250 | -0.009 | 2.712 | 162.74 |
| Ayalem, K. G. (2018) | Taxi | Bus | 0.632 | 0.888 | 0.711 | 42.70 |
| | Private Car | | 1.544 | 0.829 | 1.862 | 111.75 |
| | Train | | -5.009 | -2.072 | 2.417 | 145.05 |
| Ali, F. (2018) | Model 1 | LBUS | -0.084 | -0.1 | 0.84 | 50.40 |
| | Model 2 | | -0.084 | -0.106 | 0.792 | 47.55 |

## 2.7 Empirical Overview and Conceptual Framework

Empirical studies concerning VOT have provided a good insight into the wide diversity in how travel time is valued across various demographic groups, travel modes, and geographic contexts. Research findings showed that significant differences in the VOT depend on the income level, urbanization, and efficiency of the transport system, whereas VOTs in developed countries are generally higher compared to developing regions. New emerging trends also reordered conventional travel time valuation patterns, such as digital connectivity and flexible work arrangements. Synthesizing these insights, the conceptual framework that integrates the main explanatory variables and methodological approaches for the estimation of VOT is considered in this study. In this regard, the research design and methodology are informed by this framework to ensure the analysis of VOT in commuter travel is well representative.

### 2.7.1 Empirical Findings in VOT Studies

Empirical studies of VOT have resulted in different values for different geographical regions and demographic groups. Studies in developed countries have given higher values of VOT compared to studies in developing nations, where the income levels and transport infrastructure are considerably different (Wondemu 2016, Odeck & Brathen 2018). Even when values of time are converted into a common currency using purchasing-power-parity (PPP) exchange rates, estimates in high-income countries remain substantially higher than those in developing economies. PPP adjustment narrows but does not eliminate the gap, implying that beyond pure income effects, factors such as greater opportunity costs of in-vehicle time (e.g. ability to work or rest), higher expectations for comfort and reliability, and more extensive travel options all drive up the marginal utility of time savings in wealthier contexts (Abrantes & Wardman, 2011; Small, 2012). Rapid urbanization has also been investigated, and evidence that congestion with a lack of adequate public transport systems can increase VOT (Razavi & Titheridge 2020).

### 2.7.2 Conceptual Framework

Consistent with the objectives of this study, commuters' value of time was estimated by incorporating key socio-economic variables (income, age, gender) alongside trip attributes (travel time, cost) within a mixed logit discrete choice framework. The analysis relies exclusively on data from our carefully designed stated-preference survey (Bliemer & Rose, 2024) and follows the estimation procedures outlined by Train (2009) to capture heterogeneity in time-sensitivity across individuals.

## 2.8 Summary & Research Gaps

In light of the above, the literature review demonstrates that while the concept of VOT has been extensively explored in transportation economics, there is a substantial research gap regarding its application in the Ethiopian context, particularly within passenger transport. The first gap is the calculated VOT values from previous discrete choice experiments are outdated which needs to be updated regularly. In addition, only few existing studies applied stated preference technique for discrete choice experiment and also lacks detail information of survey design considerations stated in the previous section 2.5.1. Finally, direct VOT studies were related to the value of time of public services, there remains a significant dearth of research that comprehensively addresses the broader aspects of time valuation in passenger transport. This study seeks to bridge some gaps by examining the VOT in morning work commuter trips in the city of Addis Ababa, Ethiopia, and investigating how socio-demographic factors, distance, mode choice, and gender influence the perception of time value. It is through this exploration that this research aims to contribute valuable insights to transportation management and policy development in the Ethiopian context. Even though updating VOT values at a city level with one study is not sufficient, this study showcases methodology and findings that could be adopted city-wide.

In the following chapter, the methods used to collect data and design the SP Survey are presented in detail.

# 3. Methodology

## 3.1 Research Design

This study employed a Stated Preference (SP) survey approach to estimate the Value of Travel Time (VOT) for morning work commuter trips. The SP method is chosen over Revealed Preference (RP) techniques because it allows for controlled variation of key attributes, such as travel time and cost, which may not exhibit sufficient variation in real-world data. Additionally, SP surveys enable researchers to explore hypothetical scenarios that capture commuters' trade-offs between different travel options, providing more flexibility in model estimation. The methodology consists of survey design, data collection, data processing, model specification, estimation of VOT, and validation procedures.

## 3.2 Survey Design and Data Collection

SP surveys may be designed through any of a set of different response formats that affects the way the respondents will present their choice regarding travel options and trade-offs. The widely applied format is Choice-Based or, as often denoted, discrete choice format in which a respondent chooses from a choice set of hypothetical options provided. Correspondingly, the underlying probabilistic modeling of choice-like logit or probit-finds it particularly suitable for estimation of the value of travel time (Train, 2009).

By asking respondents to rank the alternatives in order of preference, we obtain ordinal data suitable for rank-ordered (or exploded) logit models (Train, 2009). In such models, the utility parameters for travel time and cost are estimated from the ranked choices, and the value of time is then computed directly as the ratio of the time coefficient to the cost coefficient ($\beta\_time/\beta\_cost$). Although ranking tasks can increase cognitive effort, they yield rich preference information that improves the precision of VOT estimates. Model estimation and interpretation of behavioral response strongly depend on the choice of response format; hence it is one of the most important aspects in SP survey design (Sanko, 2001).

### 3.2.1 Survey Design

The first step in designing SP experiments is to choose which type of response forms you will utilize. Out of the four common types, the research employed a choice experiment.

**Step 1: Labelled versus unlabelled experiment**

This research employed unlabelled experiment. Respondents were asked to trade-off two modes having distinct attributes of time and cost.

**Step 2: Determine alternatives and attributes**

The main attributes that were considered in this research are income, time and cost to estimate the value of travel time of commuters. Income distribution was adopted from the ESS 2022 census. Based on Gebremeskel et al. (2023) finings, the estimated average distance and time of commuter in Addis Ababa were used for determining the time and cost attributes. Transportation tariffs of various public transport modes in Addis Ababa City (details in Appendix B1) were collected and regression equations were fitted to determine the cost values of corresponding average distance values which are presented in Table 3. To determine cost of private transport, a data from popular Ride sharing company, *RIDE 8294*, was used. From the publicly available data of *RIDE 8294* app, we extracted trip costs of random 100 representative trips across the city and regression equations were fitted. Based on these existing prices, they were used to proxy the cost attribute levels for the pilot study. For private car users, we validated the cost values using the average distance travelled by respondents multiplied by the respective fuel price at the time of survey. The computed private cost amounts were in line with the range selected in the pilot which remained constant in the main survey. Attribute levels used in the main survey are summarized below.

**Table 3. Public Transport Tariffs**

| Mode | Average Distance Revealed (Km) | Tariff for Average Distance (Birr) |
|---|---|---|
| **LRT** | 8.92 | 7.00 |
| **City Bus** | 19.93 | 19.93 |
| **Midi-Bus** | 14.00 | 16.00 |
| **Mini-Bus** | 15.05 | 28.00 |

**Table 4. Attributes and Levels used in the study**

Option 1: "PT"

| Attribute | Attribute Levels | | |
|---|---|---|---|
| Time (min) | 45 | 90 | 120 |
| Cost (Birr) | 10 | 30 | 80 |
| | Low | Medium | High |

Option 2: "PrT"

| Attribute | Attribute Levels | | |
|---|---|---|---|
| Time (min) | 30 | 60 | 90 |
| Cost (Birr) | 100 | 310 | 450 |
| | Low | Medium | High |

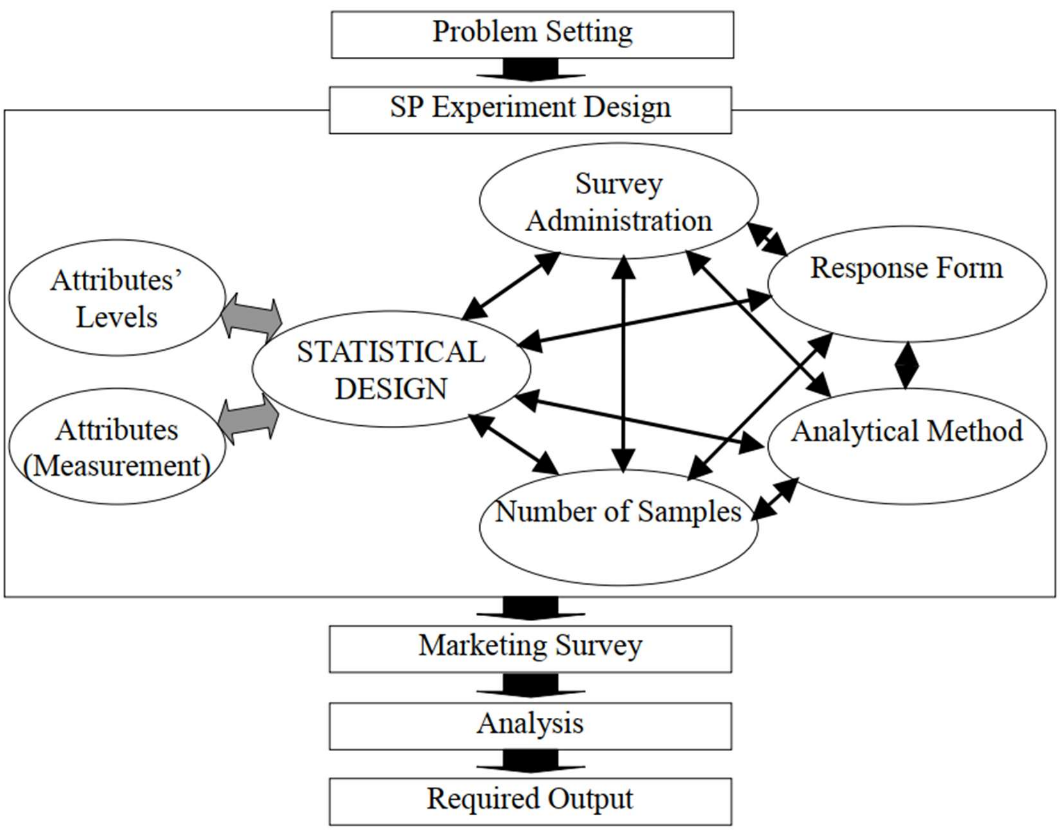



**Figure 5. The SP Experiment Flowchart. (Adopted from Sanko, 2001)**

### 3.2.2 Sampling Strategy and Target Population

The target population for this study consists of morning commuters for the purpose of work in the city of Addis Ababa, Ethiopia. A stratified sampling approach was used to ensure representative diversity in terms of age, income level, mode of transport, and frequency of commuting. The sample size was determined using power analysis to ensure statistical robustness.

- **Sample Size and Population:** According to Schiefer and Schiefer (2021), the formula for calculating sample size for estimating a population proportion with a 95% confidence level is:

$$n = \frac{z^2 \cdot [p \cdot (1-p)]}{E^2} \quad (2)$$

Where:

- n = required sample size
- Z = Z-score (1.96, 95% confidence level)
- p = estimated population proportion
- E = margin of error

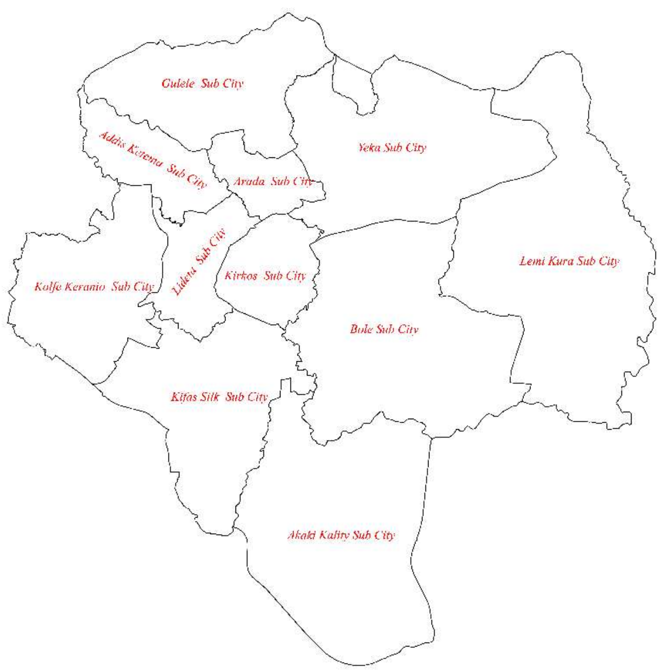



**Figure 6. Addis Ababa City Administrative Boundary (AACAPDC, 2022)**

Using the above equation, to estimate the proportion of residents in Addis Ababa City who value their travel time (p) with a 95% confidence level and a margin of error (E) of 5%. The critical Z-score for a 95% confidence level is approximately 1.96.

Using the formula:

$$n = \frac{1.96^2 \cdot [0.5 \cdot (1-0.5)]}{0.05^2} = \frac{3.84 * 0.5 * 0.5}{0.0025}$$

$$n = \frac{0.9604}{0.0025} = 384.2$$

Rounding up to the nearest whole number, you would need a sample size of approximately 400 respondents. Therefore, the research had targeted a sample size of 400 workers across the City of Addis Ababa City, Ethiopia. This sample size has been determined to ensure adequate variation of socio-economic and demographic categories which enables a robust analysis of the value of travel time (VOT) across different segments of the community. Each responder is required to trade-off six choice experiments with a total target population of 400*6 = 2,400. However, future studies should increase the number of sample sizes in different categories in order to capture the variation and estimate more accurate VOT values.

### 3.2.3 Survey Administration

The structure of the survey employed in this research is explained below.

The initial section of the section first section describes the purpose of the survey, information about the researcher and declaration about the study's policy of data privacy and anonymity of responses.

The SP survey had three parts – screener questions, socio-demographic questions and finally choice exercises. The SP surveys in this research were prepared in Amharic, the national language of Ethiopia, to ensure that respondents could easily understand the questions and provide clearer, less biased answers. The screen questions include a key segmentation variable which is personal income. Next, questions about the socio-economic and demographic of the respondent were asked, including the time and cost of the recent trip he/she has taken to the workplace, age, household income, gender, marital status, educational status etc., Following that, respondents were presented with six choices to trade off time and cost based on their mode choice. Given that discrete-choice experiments were unfamiliar to the residents of Addis Ababa City population, the survey was limited to six questions, fewer than is customary, to strike a balance between respondent burden and statistical precision. Finally, respondents were asked to rate the difficulty of the survey. The details of the surveys that were used in this research are presented in Appendix B.

Respondents were surveyed at their various offices (public and private) with the help of supervisor, which will make it convenient to make decisions without rushing. The survey was administered using a combination of online and paper-based questionnaires to maximize response rates. Data collection took place over a period of three months, and steps were taken to minimize bias, such as randomizing the order of choice tasks and conducting a pilot survey before full deployment.

### 3.2.4 Pilot Study

The pilot study was conducted from March 13,2024 and March 26, 2024, for assessing the effectiveness of the survey tool and identifying any issues before conducting the main data collection. A paper questionnaire was distributed among people at their office locations to allow them to express their traveling behaviors in their commuting to work. To allow a representative initial analysis, 10% of the expected total sample size of 400 was collected and analyzed. The primary objective of the pilot study was to evaluate the readability of the questions, the response rate, and any ambiguity in the survey instrument.

Feedback from the pilot study was analyzed in order to refine the questionnaire and its organizational structure. Recommendations made by respondents played a significant role in identifying areas that needed to be revised, particularly regarding how questions were worded, and how the survey was organized. Results from this phase are outlined under the results section. Based on the insights gained, necessary changes were made to enhance the overall effectiveness of the survey before proceeding to the main research phase.

### 3.2.5 Data Collection

Following the pilot study, the main data collection phase was conducted with improvements based on the preliminary findings. One significant adjustment was the revision of the income categorization in the screener questions. Initially, the personal income categories consisted of ten groups, but to simplify the response process and ensure sufficient representation across different income levels, the number of categories was reduced to six. This modification made it easier for respondents to state their income category without hesitation, as people are often sensitive about disclosing personal financial information for various reasons and maintaining meaningful distinctions for analysis. Additionally, new questions were incorporated to gain deeper insights from the main study. For instance, questions regarding the start time of trips, the introduction of electric cars as a mode choice alternative were added. Finally, minor grammatical refinements were made to enhance the clarity and effectiveness of the questionnaire.

With the refined questionnaire, the main study aimed to collect comprehensive data on commuter travel preferences. The revised structure streamlined the survey process, improved response rates, and minimized potential misunderstandings. Given that the main study required a large number of respondents, both online and paper-based questionnaires were used to maximize reach and participation. The data gathered from this phase serves as the foundation for the core analysis of the study, ensuring a robust and reliable evaluation of travel time valuation.

## 3.3 Data Processing and Preparation

Before analysis, the collected data underwent cleaning and preprocessing. Each step is explained briefly below.

### 3.3.1 Handling missing values by imputation or exclusion.

Survey datasets often contain gaps where respondents skip questions or provide implausible answers. To address this, we first examined the pattern and extent of missingness distinguishing between data missing completely at random (MCAR) and missing at random (MAR). According to Schafer & Graham, 2002, it is suggested where critical trip-attribute responses (such as travel time or cost) were systematically absent or logically inconsistent, those records were excluded to avoid biasing parameter estimates.

### 3.3.2 Ensuring logical consistency.

Next, we checked each respondent’s stated preferences for internal consistency. This involved flagging choice sets in which a supposedly dominant alternative was rejected (e.g., a faster, cheaper option chosen over a slower, more expensive one) or where ranking responses contradicted prior binary choices. Respondents exhibiting multiple such anomalies were reviewed in detail: isolated inconsistencies were corrected or removed at the choice-set level, while patterns indicating disengaged answering (e.g., straight-lining) led to exclusion of the entire survey from the analysis (Bliemer & Rose, 2024). After the two procedures outlined above the total sample were reduced to 345 to be used for estimation.

### 3.3.3 Coding categorical variables for use in econometric models.

Many of our explanatory variables, such as gender, income bracket, and mode familiarity, were originally recorded as nominal categories. We converted these into dummy variables (0/1 indicators) for inclusion in logit-based utility functions, ensuring that each category's effect on choice probability could be estimated separately. Where ordinal variables existed (e.g., education level), we tested both linear and stepwise coding schemes to assess whether a simple numeric ordering or distinct category dummies provided a better model fit (Hensher, Rose & Greene, 2005).

### 3.3.4 Computing summary statistics to understand key patterns and distributions.

Before fitting any choice models, we generated univariate and bivariate summaries to explore the data's central tendencies and variability. This included means, medians, standard deviations for continuous variables, as well as frequency tables for categorical attributes. Cross-tabulations and histograms revealed patterns such as skewed income distributions or mode-use frequencies that informed subsequent specification choices. These descriptive insights also guided our selection of interaction terms and segmentation strategies in the final modeling stage (Field, 2013).

## 3.4 Estimation of Value of Travel Time (VOT)

In this study, the value of travel time (VOT) is estimated via a discrete mode-choice framework. First, a multinomial logit model was specified in which the utility of each alternative depends on travel time (TT) and travel cost (TC), with the private-transport alternative serving as the reference category. The initial ("base") specification, featuring TT and TC as linear predictors exhibited relatively low explanatory power and yielded insignificant coefficients for certain parameters. To address the large-scale differences in attribute values, particularly for the public-transport alternative, a feature-engineering step was undertaken: TT and TC were scaled by 10 for the public-transport option only. This selective scaling reduced attribute variance, re-balanced utility comparisons across modes, and substantially improved overall model fit.

Subsequently, interaction effects were introduced to capture heterogeneity in VOT across socio-economic and demographic segments. Dummy variables representing gender, income brackets, age groups, education levels etc. were each interacted with TT and TC to assess whether marginal rates of substitution between time and cost differed among traveller groups. Interaction terms with t-ratios exceeding the critical threshold ($|t| > 1.96$) were retained in the final specification. This approach reveals, for instance, how VOT estimates vary for high-income females compared with low-income males. Finally, two-way contingency tables were constructed for each significant predictor to examine the joint distribution of mode-choice outcomes and socio-demographic factors. Segment-specific VOTs were then calculated as the ratio of the estimated time coefficient to the estimated cost coefficient ($VOT = \beta\_TT/\beta\_TC$) and summarized to illustrate differences in travel-time valuation among commuter groups in Addis Ababa City.

### 3.4.1 Model Selection Criteria

Selecting an appropriate model for discrete choice analysis involves evaluating several statistical and practical criteria. Key considerations include the goodness-of-fit measures, such as the log-likelihood value, McFadden's pseudo R-squared, and the Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) (Hensher et al., 2015). These metrics help compare competing models and identify the one that best balances complexity and explanatory power (Washington et al., 2020). Additionally, the theoretical plausibility of the estimated coefficients and their alignment with prior research should be assessed. For instance, a model with a higher log-likelihood but counterintuitive coefficient signs may be less desirable than a simpler, more interpretable model (Ortúzar & Willumsen, 2011). Cross-validation techniques, such as splitting the dataset into training and testing subsets, can further ensure the model's robustness and generalizability (Koppelman & Bhat, 2006).

### 3.4.2 Inclusion/Exclusion Criteria of Estimated Coefficients

The selection of coefficients for the final mode-choice specification was guided solely by empirical fit, statistical reliability, and theoretical interpretability. First, each candidate parameter whether a main effect or an interaction was retained only if it achieved statistical significance ($|t\text{-ratio}| > 1.96$,

$p < 0.05$), ensuring that every term contributed meaningfully to explaining travel-mode utility. Second, overall model performance was monitored using the log-likelihood at convergence (LL(final)) and the adjusted pseudo $R^2$; any addition of a coefficient was accepted only if it led to a less-negative LL(final) and a discernible increase in pseudo $R^2$, signifying improved explanatory power relative to the null model. Third, to balance fit against complexity, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were calculated for each candidate specification, and only those models exhibiting lower AIC and BIC values indicating more parsimonious yet well-fitting structures were advanced. Fourth, individual p-values were examined: parameters with $p > 0.05$ were excluded, unless strong theoretical justification mandated their retention for behavioral interpretability. Finally, among competing specifications with similar fit statistics, the more transparent and theory-consistent model was preferred, thereby ensuring that the final discrete-choice estimation remained both robust in its capture of commuter behavior in Addis Ababa Cityand clear in its derivation of segment-specific value-of-time estimates.

### 3.4.3 Biogeme

All discrete choice models were estimated using the Python-based Biogeme package (Bierlaire, 2003). Biogeme's flexible syntax allowed for straightforward specification of alternative-specific constants, attribute scaling, and interaction terms, as well as automated computation of fit statistics (LL(final), pseudo $R^2$, AIC, BIC) and robust standard errors. The full model estimation code, including data preprocessing steps, scaling transformations, and interaction definitions, is provided in Appendix E.

The following chapter presents the findings of the discrete choice model estimation and a description of the VOT values in base and interaction effect with social, economic and demographic variables.

# 4. Results & Discussions

## 4.1 Introduction

This present chapter intends to highlight the results derived from the data analysis. Further, key findings are discussed in relation to the stated research objectives. It begins with describing an overview of the characteristics of data collected through descriptive analysis, followed by an overview of demographic and travel behavioral characteristics of respondents. Then, the findings of the pilot and main studies will be presented through the model estimation results and their interpretation. The discussion section puts the findings into context by relating them to prior literature and considering what these findings mean for transportation planning and policy. Finally, potential limitations of the study are discussed, along with considerations for future research.

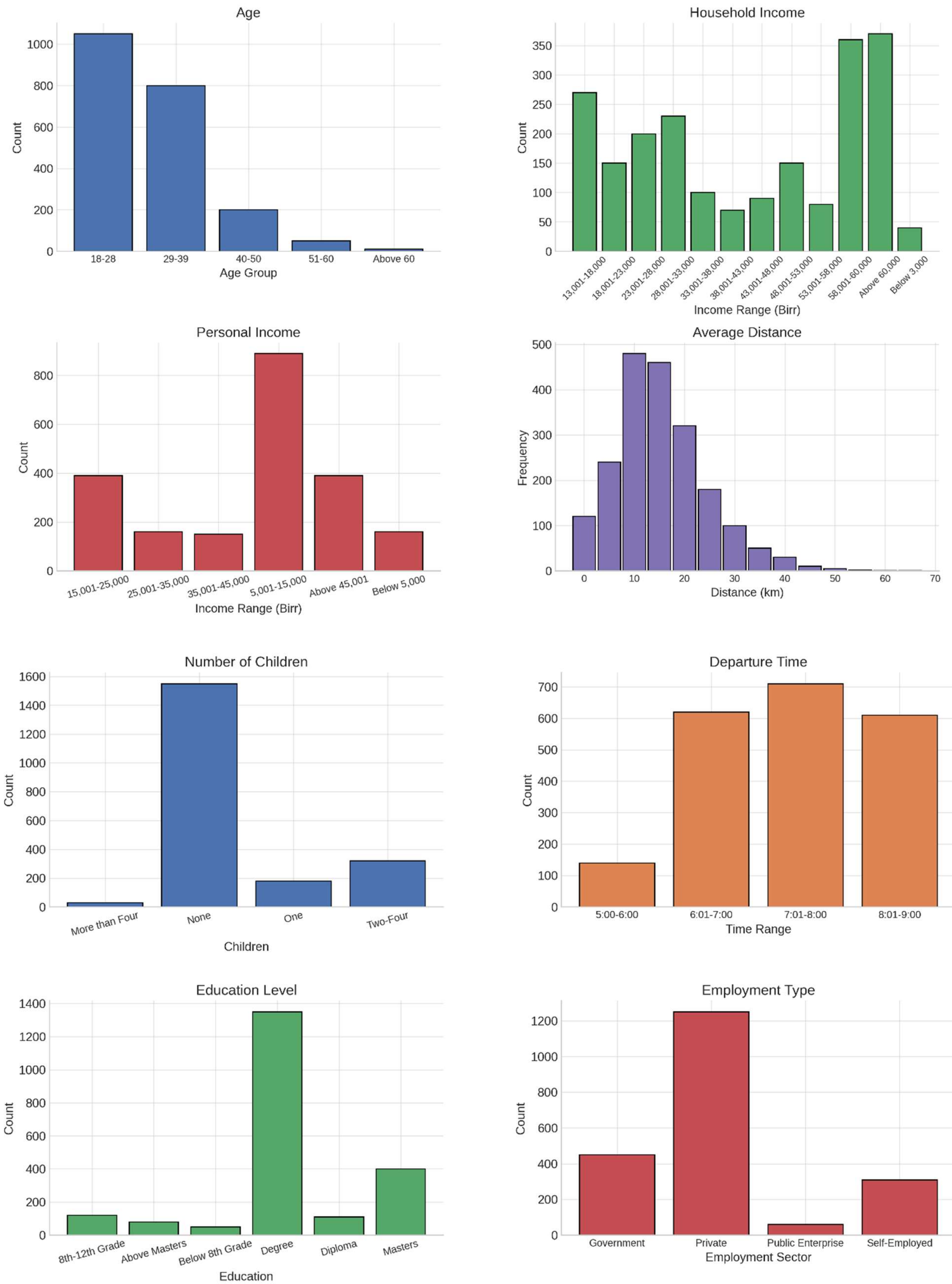
## 4.2 Descriptive Analysis

The descriptive analysis provides a detailed profile of the dataset utilized in this research, outlining the key characteristics of the respondents and their trip-making preferences. The sample encompasses individuals from diverse demographic backgrounds, segmented by factors such as age, income levels, occupation types, and commuting habits. A full breakdown of these demographic classifications and their corresponding distributions is provided in Appendix C, offering readers an opportunity to explore the data in greater detail.

**Table 5. Some Demographic Information *of respondents***

| Variables | Pilot Survey | Main Survey |
|---|---|---|
| **Gender** | | |
| **Male** | 75.0% | 71.0% |
| **Female** | 25.0% | 29.0% |
| **Mode of Transportation** | | |
| **LRT** | 0.0% | 0.3% |
| **City Bus** | 8.0% | 11.3% |
| **Midi-Bus** | 5.0% | 3.8% |
| **Mini-Bus Taxi** | 48.0% | 59.7% |
| **Lada Transport** | 5.0% | 1.7% |
| **Ride Hailing Services** | 3.0% | 7.0% |
| **Private Car** | 33.0% | 16.2% |

The demographic breakdown of respondents in both the pilot and main surveys reveals notable shifts in representation across key categories. For instance, while the proportion of male respondents decreased slightly from 75% in the pilot survey to 71% in the main survey, the share of female respondents increased correspondingly, indicating an increase gender distribution in the larger sample.


Age
Count
Age Group
18-28
29-39
40-50
51-60
Above 60
Household Income
Count
Income Range (Birr)
13,001-18,000
18,001-23,000
23,001-28,000
28,001-33,000
33,001-38,000
38,001-43,000
43,001-48,000
48,001-53,000
53,001-58,000
58,001-60,000
Above 60,000
Below 3,000
Personal Income
Count
Income Range (Birr)
15,001-25,000
25,001-35,000
35,001-45,000
5,001-15,000
Above 45,001
Below 5,000
Average Distance
Frequency
Distance (km)
Number of Children
Count
Children
More than Four
None
One
Two-Four
Departure Time
Count
Time Range
5:00-6:00
6:01-7:00
7:01-8:00
8:01-9:00
Education Level
Count
Education
8th-12th Grade
Above Masters
Below 8th Grade
Degree
Diploma
Masters
Employment Type
Count
Employment Sector
Government
Private
Public Enterprise
Self-Employed

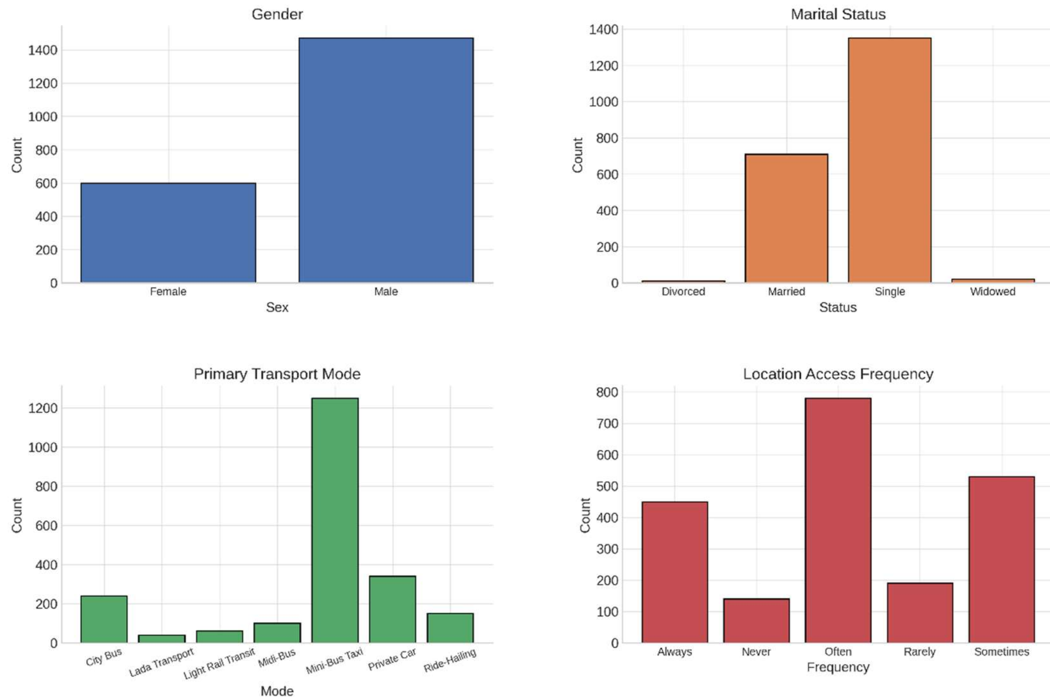



**Figure 7. Social, Economic, Demographic and Mode Distributions of the Main Study**

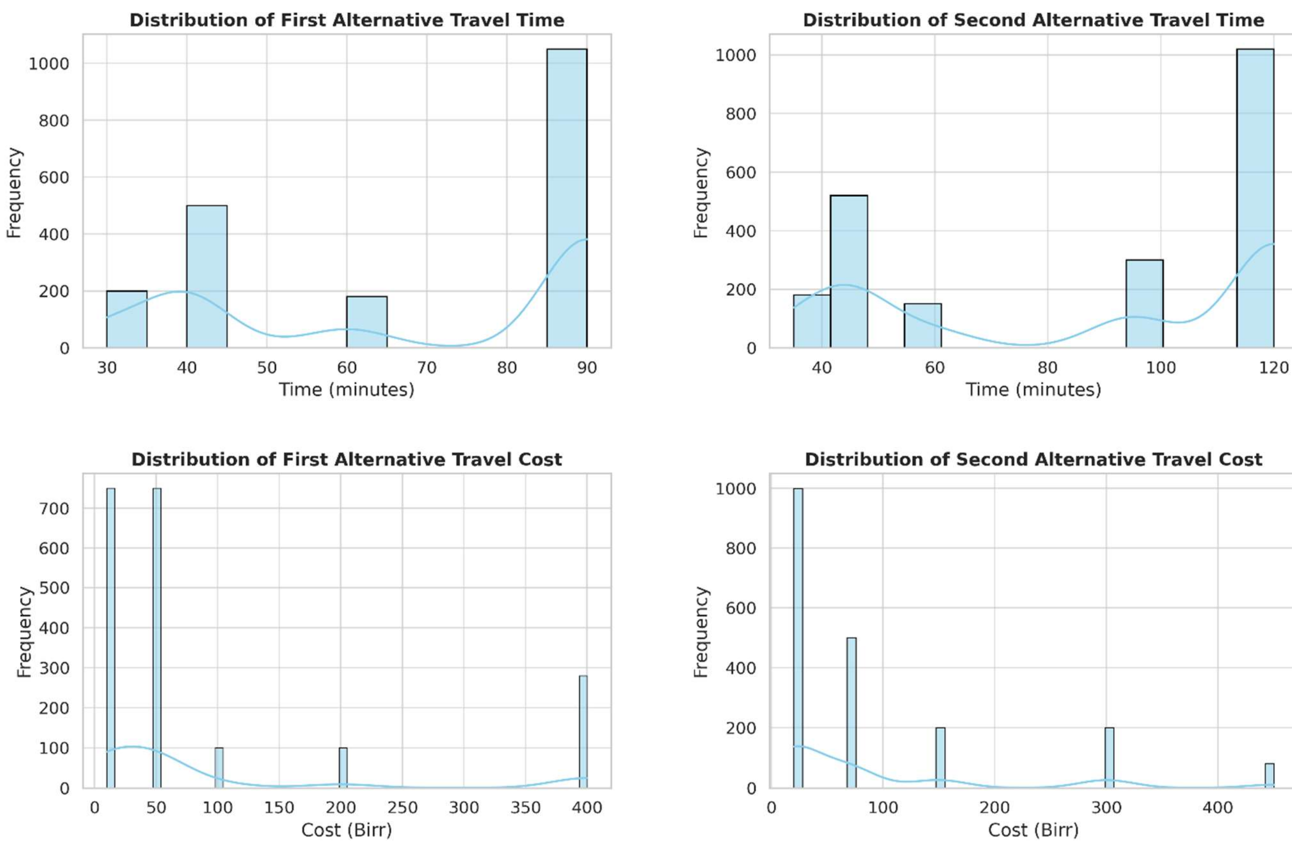



**Figure 8. Distribution of Travel Time and Cost Attributes**

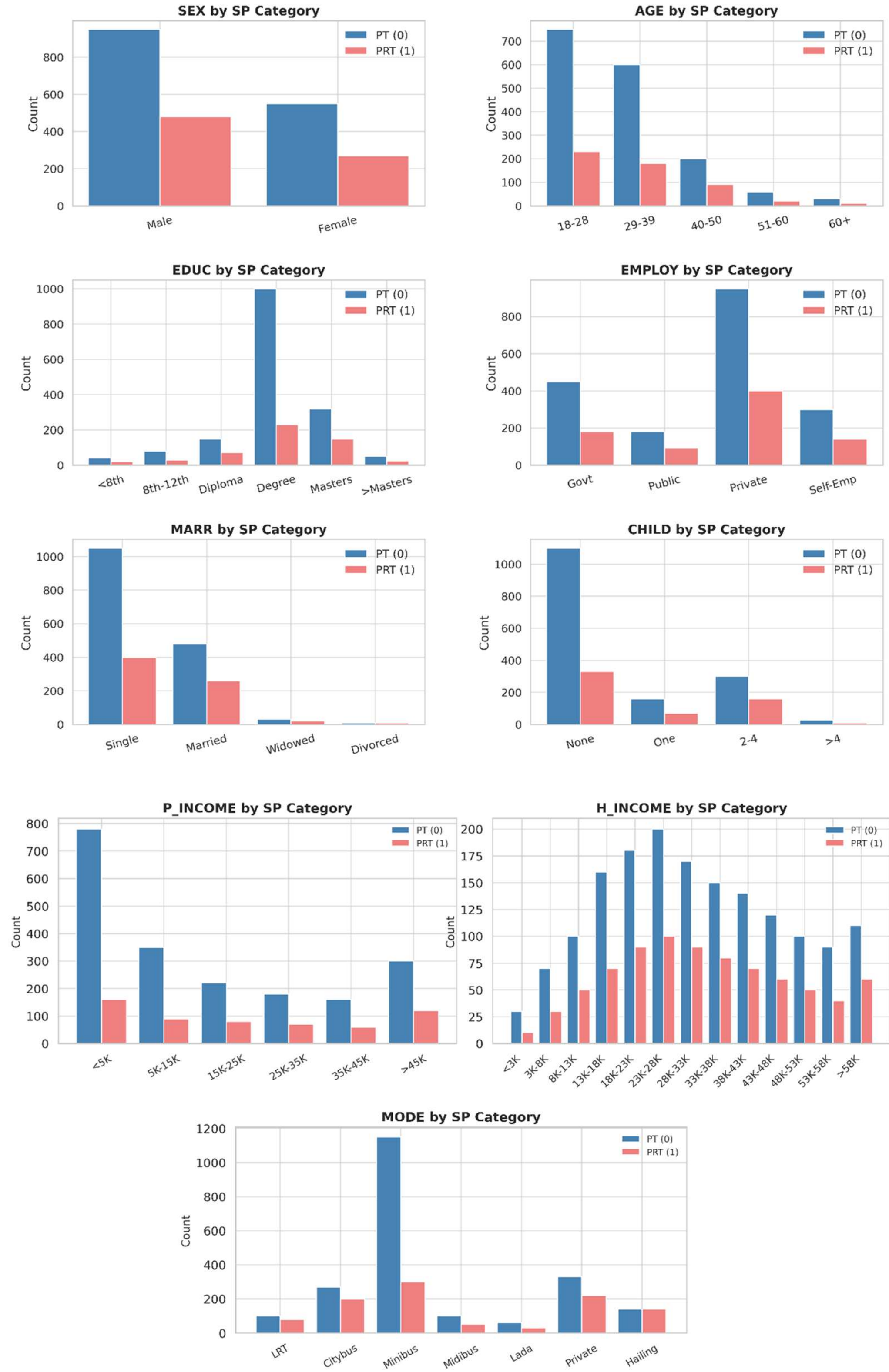



**Figure 9. Comparison of Socio-Economic Variables across the SP Categories**

## 4.3 Discrete Choice Models

This section presents the estimation results of Multinomial Logit (MNL) models on the pilot and main study.

### 4.3.1 Pilot Study Results & Insights

During the pilot study simple Multinomial Logit (MNL) model, includes only Alternative Specific Constants (ASC), Travel Time (TT), and Travel Cost (TC) was implemented. In order to enhance the impact of each social, economic and factors on travel behavior, additional models were estimated by introducing one socio-demographic variable at a time. However, the base model was found to be a better fit compared to the other models.

$$V_{First} = ASC_{First} + BETA_{TT} * First_{TT} + BETA_{TC} * First_{TC} \quad (3)$$

$$V_{Second} = ASC_{Second} + BETA_{TT} * Second_{TT} + BETA_{TC} * Second_{TC} \quad (4)$$

$$VOT(Birr/hr) = (BETA_{TT}/BETA_{TC}) * 60 \quad (5)$$

where: V = Utilities of the first and second options

ASC= Alternative Specific Constants

BETA= Coefficients of respective variables – travel time (TT) and cost (TC)

The model selection criteria are based on:

- **Adjusted $R2$ (McFadden's $\rho^2$)**: Indicates how well the model improves over a null model. Higher values suggest better fit.
- **Akaike Information Criterion (AIC)**: Measures model fit while penalizing complexity. Lower values indicate better models.
- **Bayesian Information Criterion (BIC)**: Similar to AIC but applies a stronger penalty for complexity. Lower values indicate better models.

The estimation results from the pilot study are presented in Table 6. The final log-likelihood value of -136.2 and an adjusted $R^2$ of 0.164 (16.4%) indicate a reasonable model fit at the preliminary stage. The alternative-specific constant (ASC) for the second mode option is negative (-0.279) with a t-test statistic of -1.83, suggesting that respondents exhibited a slight preference for the base alternative. The reference group was public transport where the alternative specific constant of the first option was estimated to be zero. Both the $BETA_{TT}$ and $BETA_{TC}$ parameters are negative and statistically significant, indicating that higher travel costs and longer travel times reduce the likelihood of choosing a particular mode. The estimated VOT from the pilot study is 4.33 Birr per minute, which translates to 259.63 Birr per hour. These values provide an initial benchmark for understanding commuter preferences and the trade-offs they make between time and cost. The insights from the pilot study guided necessary modifications in the survey, including simplifying income categories, refining question wording, and adding new variables to enhance the robustness of the main study.

**Table 6. Parameter Estimates of Pilot Aggregate Model**

<table>
<tr><th>Parameters</th><th>Value</th><th>Rob. Standard Error</th><th>Rho-square t-test</th><th>Final log likelihood</th><th colspan="3">Goodness to fit</th></tr>
<tr><td>$ASC_{Second}$</td><td>-0.279</td><td>0.153</td><td>-1.83</td><td rowspan="3">-136.1</td><td rowspan="2">Adjusted $R^2$</td><td rowspan="2">AIC</td><td rowspan="2">BIC</td></tr>
<tr><td>$BETA_{TC}$</td><td>-0.004</td><td>0.001</td><td>-3.85</td></tr>
<tr><td>$BETA_{TT}$</td><td>-0.016</td><td>0.003</td><td>-5.22</td><td rowspan="3">0.164</td><td rowspan="3">278.3</td><td rowspan="3">288.7</td></tr>
<tr><td>VOT(Birr/min)</td><td>4.33</td><td></td><td></td><td></td></tr>
<tr><td>VOT(Birr/hr)</td><td>259.63</td><td></td><td></td><td></td></tr>
</table>

*4.3.1.1 Variation in Value of Travel Time Across Income Groups*

The pilot study also examined how the Value of Travel Time (VOT) varies across different income groups to identify patterns in morning work commuter preferences. Table 7 presents the estimated VOT in Birr per minute and Birr per hour across income categories. The ten incomes groups were categorized to low (< 18,000 Birr), middle (18,000 – 33,000) and high income (≥ 33,000) to explore relationship of VOT and income. The results indicate a general trend where individuals with higher incomes tend to have higher VOT, reflecting their greater willingness to pay for time savings.

**Table 7. VOT per income groups of the Pilot Study**

| Income groups | VOT(Birr/min) | VOT(Birr/hr) |
|---|---|---|
| **Low Income** | 1.858 | **111** |
| **Middle Income** | 4.987 | **299** |
| **High Income** | 8.233 | **494** |
| **Aggregate** | 4.33 | **260** |

The encouraging patterns observed in the pilot provided strong justification for extending the analysis to the full dataset. Consequently, the main study incorporated a larger, more diverse sample and refined the income-group definitions to capture finer gradients of socio-economic status.

### 4.3.2 Main Study Results

The main study incorporated two separate stated preference (SP) surveys, one for public transport (PT) users and another for private transport (PrT) users. This distinction was necessary as the cost levels used for trade-offs differed significantly between the two groups. After scaling the first alternative (PT) values of travel time (TT) and travel cost (TC) a multinomial logit model was specified using private transport as a reference. Furthermore, interactions of socio-economic dummies were added to the base model (Appendix D). From the entire combination of socio-economic variables only household income (aggregated to three categories), Gender, Age group, Martial Status and Mode of travel have dummies that yielded at least one significant coefficient of TT & TC.

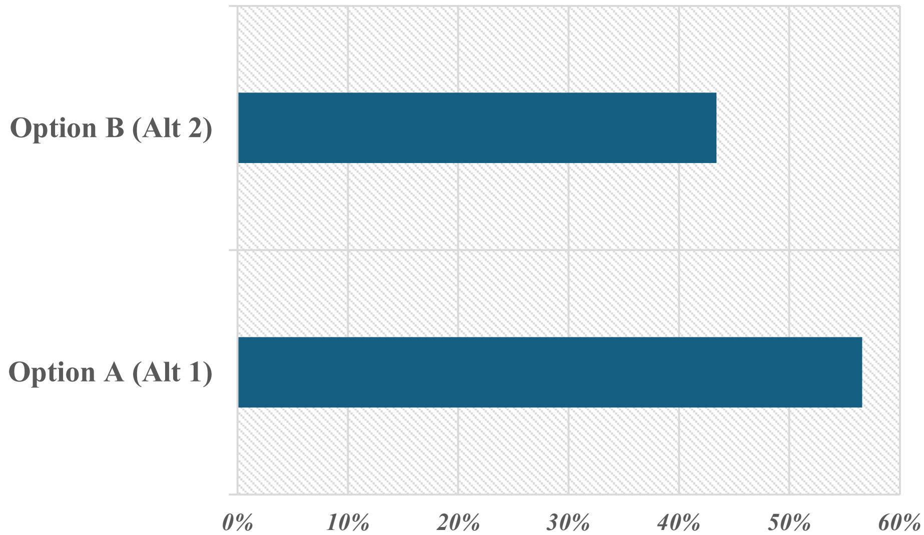



**Figure 10. Distribution of Chosen Alternatives in the Main Study**

The final utility functions of the first and second alternatives are summarized below:

$$
\begin{aligned}
V_{\text{FIRST}} = {} & \text{ASC\_FIRST} + \beta_{\text{TIME}} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST}} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Middle}} \cdot \text{Middle\_Income} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Middle}} \cdot \text{Middle\_Income} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Male}} \cdot \text{Male} \cdot \text{FIRST\_TT\_SCALED} \\
& + \beta_{\text{TIME\_Over\_60}} \cdot \text{Over\_60} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Over\_60}} \cdot \text{Over\_60} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Widowed}} \cdot \text{Widowed} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Widowed}} \cdot \text{Widowed} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Divorced}} \cdot \text{Divorced} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Divorced}} \cdot \text{Divorced} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_LRT}} \cdot \text{LRT} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_LRT}} \cdot \text{LRT} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{COST\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Lada}} \cdot \text{Lada} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Lada}} \cdot \text{Lada} \cdot \text{FIRST\_TC\_SCALED}
\end{aligned}
\tag{6}
$$

$$
\begin{aligned}
V_{\text{SECOND}} = {} & \text{ASC\_SECOND} + \beta_{\text{TIME}} \cdot \text{SECOND\_TT} + \beta_{\text{COST}} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Middle}} \cdot \text{Middle\_Income} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Middle}} \cdot \text{Middle\_Income} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Male}} \cdot \text{Male} \cdot \text{SECOND\_TT} \\
& + \beta_{\text{TIME\_Over\_60}} \cdot \text{Over\_60} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Over\_60}} \cdot \text{Over\_60} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Widowed}} \cdot \text{Widowed} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Widowed}} \cdot \text{Widowed} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Divorced}} \cdot \text{Divorced} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Divorced}} \cdot \text{Divorced} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_LRT}} \cdot \text{LRT} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_LRT}} \cdot \text{LRT} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{COST\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Lada}} \cdot \text{Lada} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Lada}} \cdot \text{Lada} \cdot \text{SECOND\_TC}
\end{aligned}
\tag{7}
$$

where: V = Utilities of the first and second choice

ASC= Alternative Specific Constants

$\beta$ = Coefficients of respective variables (TT&TC)

Low Income = <18,000 Birr, Middle Income = 18,000 – 43,000 Birr and High Income = Above 43,000

**Table 8. Reference Groups for Dummy Variables**

| Variables | Reference |
|---|---|
| **Household Income** | High Income |
| **Gender** | Female |
| **Age group** | 18-28 |
| **Marital Status** | Single |
| **Travel Mode** | Private Car |

**Table 9. Main Study Model Results with VOT by group**

| Variable | Value | Rob. Std err | Rob. t-test | Rob. p-value | Sig. | VOT (Birr/hr) |
|---|---|---|---|---|---|---|
| ASC_FIRST | −3.31 | 0.405 | −8.17 | $2.22 \times 10^{-16}$ | *** | |
| BETA_COST | −0.007 29 | 0.001 29 | −5.65 | $1.57 \times 10^{-8}$ | *** | |
| BETA_TIME | −0.0334 | 0.004 42 | −7.55 | $4.31 \times 10^{-14}$ | *** | |
| Base | | | | | | 275.0 |
| **Household Income** | | | | | | |
| BETA_TIME_Middle | 0.005 18 | 0.001 56 | 3.32 | 0.000 892 | *** | |
| BETA_COST_Middle | −0.002 16 | 0.001 02 | −2.13 | 0.0334 | * | |
| **Gender** | | | | | | |
| BETA_TIME_Male | 0.004 01 | 0.001 35 | 2.97 | 0.002 97 | ** | |
| **Age groups** | | | | | | |
| BETA_TIME_Over_60 | 0.126 | 0.0146 | 8.66 | 0 | *** | |
| BETA_COST_Over_60 | −0.169 | 0.0249 | −6.78 | $1.20 \times 10^{-11}$ | *** | |
| **Marital status** | | | | | | |
| BETA_TIME_Widowed | −0.107 | 0.007 39 | −14.4 | 0 | *** | |
| BETA_COST_Widowed | 0.159 | 0.0119 | 13.4 | 0 | *** | |
| BETA_TIME_Divorced | −0.104 | 0.006 84 | −15.2 | 0 | *** | |
| BETA_COST_Divorced | 0.153 | 0.0105 | 14.5 | 0 | *** | |
| **Current main mode** | | | | | | |
| BETA_TIME_LRT | −0.119 | 0.007 26 | −16.4 | 0 | *** | |
| BETA_COST_LRT | 0.156 | 0.0109 | 14.3 | 0 | *** | |
| BETA_TIME_City_Bus | 0.0703 | 0.0420 | 1.67 | 0.0944 | † | |
| BETA_COST_Midi_Bus | −0.0164 | 0.006 36 | −2.58 | 0.009 96 | ** | |
| BETA_TIME_Mini_Bus | −0.007 54 | 0.002 07 | −3.64 | 0.000 273 | *** | |
| BETA_COST_Mini_Bus | −0.0105 | 0.003 22 | −3.26 | 0.001 10 | ** | |
| BETA_TIME_Lada | 0.258 | 0.0147 | 17.5 | 0 | *** | |
| BETA_COST_Lada | −0.0817 | 0.007 27 | −11.2 | 0 | *** | |

**Significance:** *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$

**Value of Time (VOT) formula:**

$$\text{VOT} = (\beta_{\text{TIME}}/\beta_{\text{COST}}) \times 60 \quad \text{(Birr/hour)}$$

**Base: An individual from the reference group, choosing Private Transport.**

The VOT computed in the base model (275 Birr/hr) represents how much a single female aged 18-28, from high household income category and owning a private car, values her travel time in choosing public transport over private transport for her morning work commute. All other combinations of VOT are presented in Annex D2.

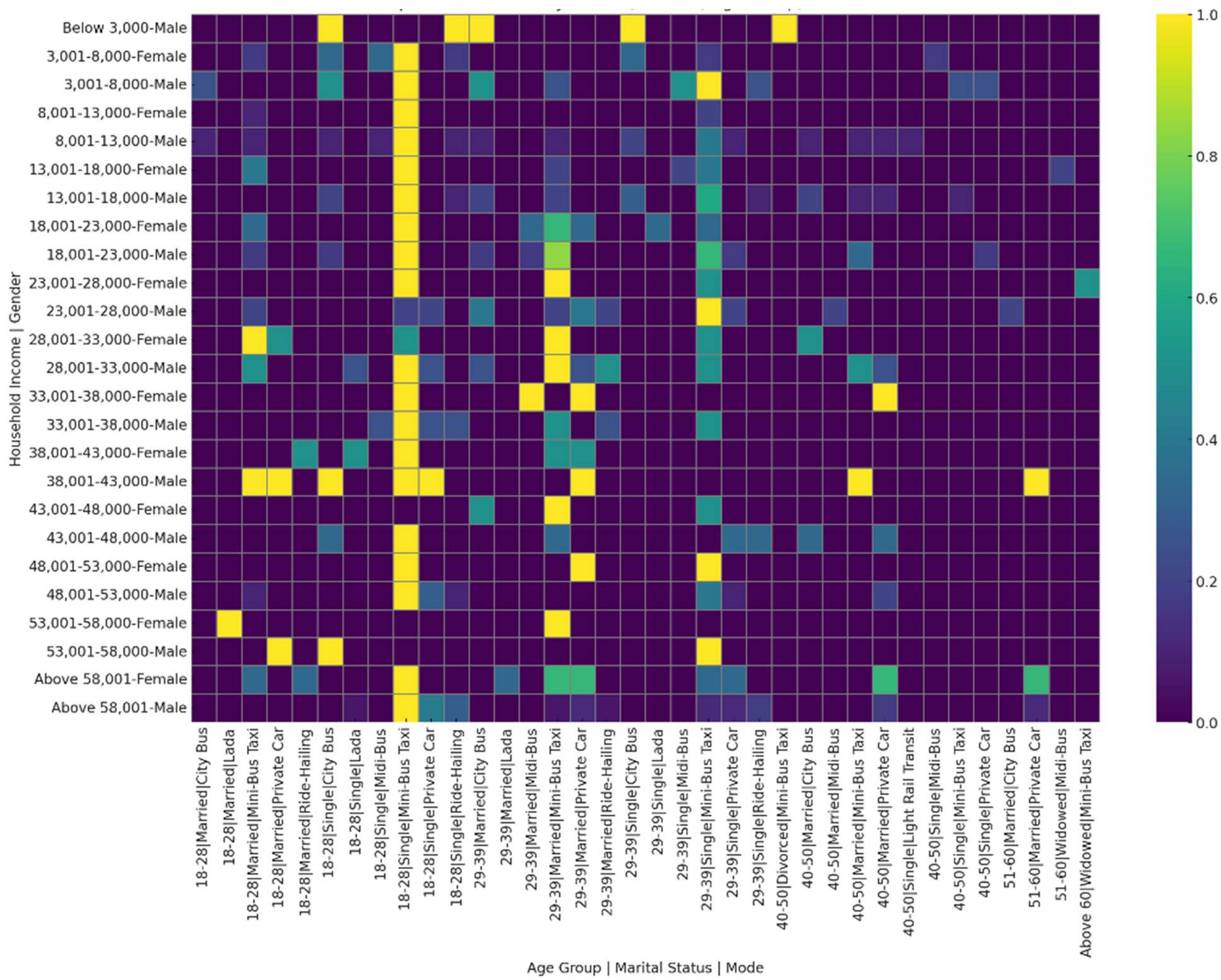



**Figure 11. Heat Map of combinations of Significant Variables**

The above graph condenses five categorical dimensions into a single matrix. Each row is a unique combination of income bracket and gender; each column is an age–marital-status pair associated with a specific mode. Cell intensity is min–max normalised (dark = no observations, yellow = row maximum) so patterns rather than absolute magnitudes are emphasized. Reading across any given row shows how a particular socio-economic slice distributes its commuting choices. For example, the "18–23 000 Birr | Male" rows glow brightest under "29-39 | Married | Mini-Bus Taxi" and "29-

39 | Married | Private Car", confirming the transitional nature of this income tier as they begin to diversify away from sole dependence on public-bus services.

### 4.3.4 Interpretation of Findings

The estimated VOTs exhibit a pronounced right-skewed distribution, with a substantial concentration of values between roughly 120 and 250 Birr/hour. For instance, insignificant variables like City-Bus users across both the lowest ("Below 3,000 Birr") and highest ("Above 58,001 Birr") income categories consistently record the highest willingness to pay for time savings (up to 275 Birr/hr) suggesting that they don't affect the based model result. Similarly, Ride-Hailing and Private-Car users in mid-income bands (e.g. 8,001–13,000 Birr; 28,001–33,000 Birr) typically fall in the 230–240 Birr/hr range, indicating fairly homogeneous time valuations among those who can afford more flexible modes.

By contrast, Mini-Bus and Midi-Bus travellers yield more moderate VOTs, often between 74 Birr/hr (e.g. younger, single riders in the 8,001–13,000 Birr group) and 136 Birr/hr (e.g. married females in the same income bracket). This suggests an interaction between mode and income: where public transport users has relatively lesser VOT values.

Approximately 30 percent of the segments produce negative VOT estimates ranging from modest anomalies (–34 Birr/hr) to highest values (down to –185 Birr/hr). These negative valuations cluster in sparsely populated socio-demographic combinations, such as divorced low-income riders on Mini-Bus Taxis (–62 Birr/hr) and Lada users aged 18–28 in the 18,001–23,000 Birr bracket (–182 Birr/hr). Negative values contradict standard economic theory, indicating potential model misspecification (e.g., missing interaction effects, nonlinearities) or Endogeneity issues (e.g., unobserved preferences for certain modes) may bias estimates. Furthermore, data limitations such as smaller sample size and bias of respondents could be source of these results.

While most VOT estimates follow expected patterns, negative values in high-income groups and certain modes warrant further investigation. Addressing data gaps and refining model specifications could improve reliability. Future research should validate these findings with larger, more diverse samples.

Figure 12. cross-classifies mode of transport (horizontal axis) against household-income group (vertical axis). Marker size is proportional to the number of respondents in each cell, while

colour/shape encode gender (× = male, ● = female) and marital status (symbol variations). Several regularities emerge. Mini-bus taxis dominate the middle of the diagram: from "3,001–8,000 Birr" up to roughly "28,001–33,000 Birr", the largest bubbles cluster over this mode, confirming its role major choice of Addis Ababa City's commuters. At the top income tier ("Above 58,001 Birr") the bubbles migrate rightward toward Private Car, reflecting the expected positive income elasticity of car ownership and use. Conversely, City Bus attracts mostly the two lowest income groups, with very small bubbles, thereafter, underscoring its affordability focus. Gender differences are modest overall, but in the highest-income class the male '×' markers are noticeably larger for private cars, whereas females register slightly more ride-hailing use, hinting at a convenience-and-safety premium. Marital-status symbols reveal that married commuters are over-represented in car and mini-bus cells, while singles dominate ride-hailing and city-bus cells. These observations mirror the contingency table that is attached in the Appendix D2.

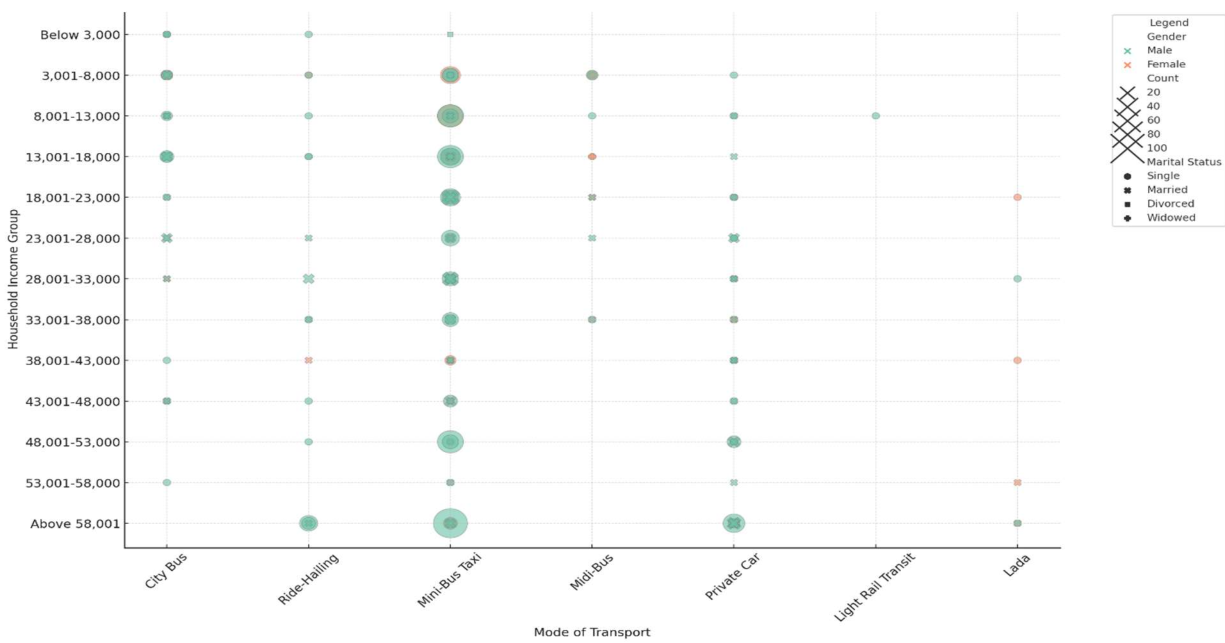



**Figure 12. Bubble Plot of Mode Choice by Household Income, Gender and Martial Status**

## 4.4 Discussion

### 4.4.1 Implications of Findings

The meta-analysis conducted by Wardman et al (2023) for the World Bank aimed to synthesize global evidence on the Value of Travel Time Savings (VTTS) in low- and middle-income countries

(LMICs), addressing critical gaps in transport project appraisal. By analyzing 760 valuations from 220 studies across 35 LMICs, the study established updated VTTS benchmarks tied to GDP per capita, journey purpose (e.g., commuting, leisure, business), and transport modes (e.g., car, public transport), while challenging conventional wage-rate-based approaches. Key findings included higher VTTS for inter-urban and business trips, justified walk/wait time premiums (~50–100% above in-vehicle time), and lower income elasticity (0.696) than previously assumed.

**Table 10.** Recommended Valuations, 2020 Prices and Incomes (Wardman, 2023)

| Variables<br>Base = Urban Commute Car User | Valuations (%)<br>VTTS = $e^{-4.191}$GDP per capita$^{0.696}$ |
|---|---|
| Public transport user | -50 |
| Walk or cycle user | -54 |
| Leisure | -37 |
| Business | +49 |
| Inter-urban | +123 |
| Walk | +101 |
| Wait | +51 |

Source: World Bank data

**Table 10** by Wardman (2023) recommended an equation for VOT when local evidence is not available. Even though we can extract VOT values from previous mode choice studies mentioned in section 2.6, there is lack of research findings estimating the value of time in the country level. Thus, by estimating the VOT for Ethiopia using its GDP, variation between Ethiopia and Addis Ababa City could be explored. Ethiopia's latest GDP per capita according to the World Bank (accessed on April 19, 2024, during data collection) was 1,027 USD. Using the Base model formula, the urban-commute car users should value travel-time savings at roughly 1.89 USD/hr. This value is in 2020 prices needed to be adjusted for income and inflation. U.S. Consumer Price Index (CPI) values for 2020 and April 2024, as reported by the Bureau of Labor Statistics (BLS) are 260.474 and 313.548 respectively. Since the most recent World Bank GDP per capita data for Ethiopia is from 2020, this research has adopted GDP per capita values from International Monetary Fund (IMF). Based on IMF estimation, the GDP per capita values for the year 2020 and 2024 is 969.014 and 1320.157 respectively.

(8)

$$VOT_{2024} = VOT_{2020} * \frac{CPI_{2024}}{CPI_{2020}} * \frac{GDP\ per\ capita_{2024}}{GDP\ per\ capita_{2020}}$$

$$VOT_{2024} = 1.89 * \frac{313.548}{260.474} * \frac{1320.157}{969.014} = 1.89 * 1.2 * 1.36 = 3.09\ USD$$

The VOT for the 2024 prices would be 3.09 USD. Its equivalent amount in birr would be around 180 Birr/hr at the official exchange rate, *CBE-Exchange Rate*, n.d. (57.96 Birr/hr at the time of data collection) or 367 Birr/hr at the unofficial rate (118.74 Birr/hr). Public-transport users are recommended to discount that base by 50 percent according to Table 10 which results (≈ 1.545 USD/hr, i.e. ~ 90 Birr/hr or 184 Birr/hr). This study assumes that the unofficial exchange rate defines the market price (VOT=367, Public Transport VOT= 184 Birr/hr). The data collection was performed before the economic devaluation of the country.

**Table 11.** VOT Comparisons across significant variables

| Variables | Wardman () | |
|---|---|---|
| **Base = An individual from the reference group, choosing Private Transport** | 275 | |
| **Age** | | |
| **Age above 60** | -16% | |
| **Household Income** | | |
| **Middle Income** | -52% | |
| **Marital Status** | | |
| **Widowed** | -22% | |
| **Divorced** | -23% | |
| **Mode Choice** | | |
| **Public Transport** | -36.1% | -13.9% |

By contrast, this study discrete-choice model produces relatively higher estimates across nearly all socio-demographic segments. For example, people in the reference group exhibit VOTs near 275 Birr/hr—significantly lower than Wardman benchmark for private transport, while for public transport moderate modes in our model (e.g. Midi-Bus users at ~ 74 Birr/hr) is also lower than meta-analytic lower bound for public transport (184 Birr/hr). In addition, comparing the meta-analysis with this study, VOT values of public transport are 13.9% lower than private transport. These differences suggest that Addis Ababa City morning work commuters place a lesser monetary premium on time savings than the "average" implied by Wardman's GDP-scaled formula for Ethiopia.

### 4.4.2 Limitations of the Study

The study's reliance on a stated-preference (SP) experiment introduces several well-known limitations. Because respondents evaluate hypothetical trip scenarios rather than make real transactions, their answers are susceptible to hypothetical bias, often leading to a willingness to trade money for time that is higher than what revealed-preference (RP) data typically show. The SP tasks also idealize the travel environment by presenting clean, noise-free comparisons of time and cost; real-world choices are clouded by crowding, reliability, and information gaps that the survey cannot fully replicate. These factors commonly push VOT estimates upward relative to RP studies, so the figures reported here should be treated as upper bounds. In addition, inference is constrained by sample-size limitations: after data cleaning, only 345 observations remained, and stratification was feasible by income group alone. This modest cell count restricts the precision of segment-specific estimates and limits the ability to explore how VOT varies simultaneously across gender, age, or trip purpose.

Despite these limitations, the study provides a strong foundation for understanding morning work commuter VOT in Addis Ababa City and offers valuable insights for transportation planning, pricing policies, and sustainable mobility strategies. Future studies can build on these findings to refine VOT estimation methodologies and develop transport policies that align with Ethiopia's evolving urban mobility landscape.

# 5. Conclusion & Recommendations

## 5.1 Summary of Key Findings

This study estimated the value of travel time (VOT) for morning commuter work trips in Addis Ababa City using a stated-preference discrete choice survey of 345 respondents. The base model yielded an aggregate VOT of approximately 275 Birr/hour when private transport was the reference alternative. These figures are less than the conventional GDP-scaled benchmark for Addis Ababa City, suggesting commuters place a particularly high premium on time savings.

Moreover, VOT exhibited marked heterogeneity across socio-demographic segments and modes. On Average higher-income household commuters (≥ 43 000 Birr/month) valued travel time savings more than middle-income groups (18,000 - 43,000 Birr/month) by 48.2%, and private transportation modes have 63.9 % higher VOTs than public-transport users. Interaction effects revealed that young single females in higher income brackets assigned the highest monetary value to time savings, while some sparse subgroups (e.g., divorced low-income mini-bus users) produced anomalous negative VOTs, indicating potential model specification issues, the influence of unobserved factors or sample size issues.

## 5.2 Practical Implications

These findings provide critical inputs for transport planners and policy-makers in Addis Ababa City. First, the elevated VOT estimates imply that time-saving measures such as dedicated bus lanes, priority signaling, and service reliability improvements will generate substantial welfare benefits; incorporating the local VOT rather than international benchmarks will improve the accuracy of cost–benefit analyses and project prioritization. Second, the observed heterogeneity underscores the need for differentiated pricing and service strategies: for instance, premium services (express buses or ride-hail options) can be priced at levels reflecting their higher-value-of-time, while ensuring affordable options remain available for lower-income users.

Furthermore, the strong willingness to pay suggests that investments in real-time information systems and measures to reduce variability (e.g., congestion management, off-peak incentives) could yield disproportionately large user benefits. Policymakers should also consider tailoring interventions to demographic groups—for example, targeting improvements in young female-oriented private car commuters to support higher VOT segments while addressing equity concerns for lower-income populations.

## 5.3 Recommendations for Future Research

To strengthen the evidence base that has emerged from this exploratory study, future work should widen both the breadth and depth of data collection. First, the sample should be enlarged well beyond the current 345 usable cases so that VOT can be estimated simultaneously across multiple socio-economic strata such as gender, age, car ownership, as well as income.

Second, the survey should incorporate additional journey purposes (e.g., shopping, social, school) together with various attributes like urgency or impact of activities during travelling to capture its variations. Including such variations will allow researchers to model purpose-specific VOT schedules and gauge the premium travellers place on reliability.

Third, to temper the upward bias that pure SP designs can introduce, a combined SP–RP design is recommended, in which stated choices are anchored to a subset of respondents' actual trips. Collectively, these enhancements will yield more precise, VOT estimates that better reflect the diversity of travel behaviour in Addis Ababa City.

# References

Abrantes, P. A. L., & Wardman, M. R. (2011). Meta-analysis of UK values of travel time: An update. *Transportation Research Part A: Policy and Practice*, *45*(1), 1–17. https://doi.org/10.1016/j.tra.2010.08.003

Aboutaleb, Y. M., Danaf, M., Xie, Y., & Ben-Akiva, M. (2021). Discrete choice analysis with machine learning capabilities. *arXiv preprint arXiv:2101.10261*.

Ali, F. (2018). Development of modal choice model for home-based work trips: The case of Jemo area residents in Addis Ababa [Master's thesis, Addis Ababa University, School of Civil and Environmental Engineering].

Ayalem, K. G. (2018). The determinants of choice of transportation mode in Addis Ababa [Master's thesis, St. Mary's University, Institute of Agricultural and Development Studies].

Beesley, M. E. (1965). The Value of Time Spent in Travelling: Some New Evidence. In New Series (Vol. 32, Issue 126).

Ben-Akiva, M., & Lerman, S. R. (1985). Discrete choice analysis: Theory and application to travel demand. MIT Press.

Bierlaire, M. (2003). BIOGEME: A free package for the estimation of discrete choice models. Proceedings of the 3rd Swiss Transportation Research Conference, Ascona, Switzerland.

Bliemer, M. C. J., & Rose, J. M. (2024). Designing and Conducting Stated Choice Experiments. In *Handbook of Choice Modelling* (pp. 172–206).

Boxall, P. C., & Adamowicz, W. L. (2002). Understanding heterogeneous preferences in random utility models: A latent class approach. Environmental and Resource Economics, 23(4), 421–446.

Commercial Bank Of Ethiopia (CBE) -Exchange rate. (n.d.). https://www.combanketh.et/en/exchange-rate/

De Jong, G., & Kouwenhoven, M. (2020). Value of travel time and travel time reliability. In Advances in Transport Policy and Planning (Vol. 6, pp. 43–74). Elsevier B.V. https://doi.org/10.1016/bs.atpp.2020.07.010

De Palma, A., Lindsey, R., & Proost, S. (2010). Urban transportation and equilibrium congestion: A structural approach. Journal of Urban Economics, 67(3), 336-345.

Dingil, A. E., & Esztergár-Kiss, D. (2021). The influence of education level on urban travel decision-making. *Periodica Polytechnica Transportation Engineering*, *50*(1), 49–57. https://doi.org/10.3311/pptr.16871

Field, A. (2013). Discovering statistics using IBM SPSS Statistics (4th ed.). Sage Publications.

Gebremeskel, E., Woldetensae, B., & Woldeamanuel, M. (2023). Travel mode preference in Addis Ababa, Ethiopia: empirical observations. Urban Planning and Transport Research, 11(1). https://doi.org/10.1080/21650020.2023.2228380

Gebeyehu, M., & Takano, S. (2007). Diagnostic evaluation of public transportation mode choice in Addis Ababa. *Journal of Public Transportation,* *10*(4), 27–50. https://doi.org/10.5038/2375-0901.10.4.2

Greene, W. H., & Hensher, D. A. (2003). A latent class model for discrete choice analysis: Contrasts with mixed logit. Transportation Research Part B: Methodological, 37(8), 681–698.

Greene, W. H. (2018). Econometric analysis (8th ed.). Pearson.

Gunn, H. F. (2008). *An Introduction to the Valuation of Travel Time Savings and Losses* (D. A. Hensher & K. J. Button, Eds.; Second).

Gwilliam, K. M. (1997). The Value of Time In Economic Evaluation of Transport Projects Lessons from Recent Research.

Hensher, D. A. (2001). Measurement of the Valuation of Travel Time Savings. *Journal of Transport Economics and Policy*, *35*(1), 71–98. http://www.jstor.org/stable/20053859

Hensher, D. A., Rose, J., & Greene, W. H. (2005). The implications on willingness to pay of respondents ignoring specific attributes. *Transportation*, *32*(3), 203–222. https://doi.org/10.1007/s11116-004-7613-8

Hensher, D. A., Rose, J. M., & Greene, W. H. (2015). Applied choice analysis (2nd ed.). Cambridge University Press.

Hensher, D. A. (2018). Value of travel time savings in the era of the sharing economy: An exploratory analysis. Transport Policy, 66, 1-8.

Koppelman, F. S., & Bhat, C. R. (2006). A self-instructing course in mode choice modeling: Multinomial and nested logit models. U.S. Department of Transportation.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2010). Stated choice methods: Analysis and applications (2nd ed.). Cambridge University Press.doi : 10.1017/CBO9780511753831

Jang, J., & Ko, J. (2019). Factors associated with commuter satisfaction across travel time ranges. *Transportation Research Part F Traffic Psychology and Behaviour*, *66*, 393–405. https://doi.org/10.1016/j.trf.2019.09.019

Mackie, P., Jara-DíAz, S., & Fowkes, A. (2001). The value of travel time savings in evaluation. *Transportation Research Part E Logistics and Transportation Review*, *37*(2–3), 91–106. https://doi.org/10.1016/s1366-5545(00)00013-2

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), Frontiers in econometrics (pp. 105–142). Academic Press.

Mokhtarian, P. L. (2009). A typology of relationships between transportation and the environment. Transportation Research Part D: Transport and Environment, 14(1), 36-47.

Ng, W. and A. Acker (2018), "Understanding Urban Travel Behaviour by Gender for Efficient and Equitable Transport Policies", International Transport Forum Discussion Papers, No. 2018/01, OECD Publishing, Paris, https://doi.org/10.1787/eaf64f94-en.

Odeck, J., & Brathen, S. (2018). Public transport planning and valuation: The case of Vestland county in Norway. Case Studies on Transport Policy, 6(3), 380-387.

Ortúzar, J. D., & Willumsen, L. G. (2011). Modelling transport (4th ed.). Wiley.

Prayag, G., Khoo-Lattimore, C., & Sitruk, J. (2015). Changing time valuations in transport: Gender, life course and travel behavior. Journal of Transport Geography, 48, 29-41.

Razavi, S., & Titheridge, H. (2020). Investigating the impact of the rapid urbanization on the value of travel time in developing cities. Transportation Research Part A: Policy and Practice, 140, 318-333.

Rahnasto, I., & Hollestelle, M. (2024). Comparing discrete choice and machine learning models in predicting destination choice. *European Transport Research Review*, *16*(1). https://doi.org/10.1186/s12544-024-00667-9

Sanko, N. (2001). Guidelines for Stated Preference Experiment Design (Professional Company Project in Association with RAND Europe).

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. Psychological Methods, 7(2), 147–177.

Schiefer, H., & Schiefer, F. (2021). Statistics for engineers: An Introduction with Examples from Practice. Springer Nature.

Shires, J. D., & de Jong, G. C. (2009). An international meta-analysis of values of travel time savings. *Evaluation and Program Planning*, *32*(4), 315–325. https://doi.org/10.1016/j.evalprogplan.2009.06.010

Small, K. A. (2014). Valuation of travel time. Journal of Transportation Economics and Policy, 48(3), 325-348.

Smith, M., & Ding, C. (2012). Gender and travel demand: The role of social influence and social networks. Transport Policy, 20, 61-71.

Small, K.A. & Verhoef, E.T. (2007). The Economics of Urban Transportation. Routledge.

Small, K. A. (2012). Valuation of travel time. Economics of Transportation, 1(1-2), 2–14. https://doi.org/10.1016/j.ecotra.2012.09.002

Teshome, M. (2007). Logit model of work trip mode choice for Bole Sub-City residents [Master's thesis, Addis Ababa University, Faculty of Technology].

Train, K. E. (2009). Discrete choice methods with simulation (2nd ed.). Cambridge University Press.

Vickerman, R. (2006). Accessibility, transport, and economic growth. Journal of Transport Geography, 14(5), 327-338.

Washington, S., Karlaftis, M. G., & Mannering, F. (2020). Statistical and econometric methods for transportation data analysis (3rd ed.). CRC Press.

Wattam, M., Flanary, R., Ahmed, F., Vaidya, K. & Wardman, M., 2005, Ardington (UK): I.T. Transport Ltd, 41 p Research output: Preprint or Working paper › Manual

Wardman, M. (1998). The Value of Travel Time: A Review of British Evidence. In Source: Journal of Transport Economics and Policy (Vol. 32, Issue 3). http://www.jstor.orgURL:http://www.jstor.org/stable/20053775

Wardman, M., & Lyons, G. (2016). The digital revolution and worthwhile use of travel time: implications for appraisal and forecasting. Transportation, 43(3), 507–530. https://doi.org/10.1007/s11116-015-9587-0

Wardman, M., & Toner, J. (2018). Is generalised cost justified in travel demand analysis? Transportation, 47(1), 75–108. https://doi.org/10.1007/s11116-017-9850-7

Wardman, M., Neki, K., & Humphreys, R. M. (2023). *Mobility and Transport Connectivity Series Meta-analysis of the Value of Travel Time Savings in Low-and Middle-Income Countries Meta-analysis of the Value of Travel Time Savings in Low-and Middle-Income Countries*.

Weldegiorgis, M. T. (2007). Logit Model of Work Trip mode choice for Bole Subcity residents [Addis Ababa University]. https://www.tesionline.it/tesi/Logit-Model-of-Work-Trip-Mode-Choice-for-Bole-Subcity-Residents/18617

Wondemu, K. (2016). The Economic Value of Time: Evidence from Africa. South African Journal of Economics, 84(2), 230–244. https://doi.org/10.1111/saje.12098

Zamparini, L., & Reggiani, A. (2007a). Meta-analysis and the value of travel time savings: A transatlantic perspective in passenger transport. *Networks and Spatial Economics*, *7*(4), 377–396. https://doi.org/10.1007/s11067-007-9028-5.

# Appendices

## Appendix A: Coding Manual

| Part I: Screener Questions | |
|---|---|
| **Question Number** | Variables and Codes |
| **-** | **Questionnaire ID.** Given a consecutive number to each survey. |
| **1** | Do you often use the transportation services (Public and/ or Private Service) provided by your employer to come to your work?<br>0 = Yes<br>1 = No |
| **2** | Based on your monthly income, which group represents you best?<br>0 = Below 5,000 Birr<br>1 = 5,001-15,000 Birr<br>2 = 15,001-25,000 Birr<br>3 =25,001-35,000 Birr<br>4 = 35,001-45,000 Birr<br>5 = Above 45,001 Birr |
| **Part II: Socio-demographic Questions** | |
| **Question Number** | Variables and Codes |
| **1** | Can you please specify your Gender?<br>0 = Male<br>1 = Female |
| **2** | Please select your age group from the following list?<br>0 = 18-28 years<br>1 = 29-39 years<br>2 = 40-50 years<br>3 =51-60 years |

| | |
|---|---|
| | 4 = Above 60 years |
| **3** | Can you please state the highest educational level you have earned?<br>0 = Below 8th Grade<br>1 = 8th -12th Grade<br>2 = Diploma<br>3 =Degree<br>4 = Masters<br>5 = Above Masters |
| **4** | Can you please indicate your current employment status?<br>0 = Government<br>1 = Public Enterprise<br>2 = Private<br>3 =Self-Employed |
| **5** | Please state your current Martial Status?<br>0 = Single<br>1 = Married<br>2 = Widowed<br>3 =Divorced |
| **6** | Can you please state your Household income?<br>0 = Below 3,000 Birr<br>1 = 3,001-8,000 Birr<br>2 = 8,001-13,000 Birr<br>3 =13,001-18,000 Birr<br>4 = 18,001-23,000 Birr<br>5 = 23,001-28,000 Birr<br>6 = 28,001-33,000 Birr<br>7 =33,001-38,000 Birr<br>8 = 38,001-43,000 Birr<br>9 = 43,001-48,000 Birr<br>10 = 48,001-53,000 Birr<br>11 =53,001-58,000 Birr<br>12 = Above 58,001 Birr |

| | |
|---|---|
| **7** | Please state how many children do you have?<br>0 = None<br>1 = One<br>2 = Two-Four<br>3 = More than Four |
| **Part III: Questions about recent trip to work** | |
| **Question Number** | Variables and Codes |
| **1** | Please state the Origin of your recent trip? (Responder Response) |
| **2** | Please state the Destination of your recent trip? (Responder Response) |
| **3** | Which mode of transport have you used during your recent trip to workplace?<br>0 = Light Right Transit<br>1 = City Bus (Anbesa/Sheger)<br>2 = Midi-Bus (Higer/Qitqit/Alliance)<br>3 = Mini-Bus Taxi<br>4 = Lada Transport<br>5 = Ride-Hailing Services (Ride,Feres..)<br>6 = Private Car |
| **For Public Transport Users (Questionnaire Type A)** | |
| **4** | Can you roughly estimate how much it has cost you during your commute? (Responder Response) |
| **5** | Can you roughly estimate how much time it has taken you during your commute? (Responder Response) |
| **6** | At what time did you start your commute?<br>0 = 5:00 AM- 6:00 AM<br>1 = 6:01 AM- 7:00 AM<br>2 = 7:01 AM- 8:00 AM<br>3 = 8:01 AM- 9:00 AM |

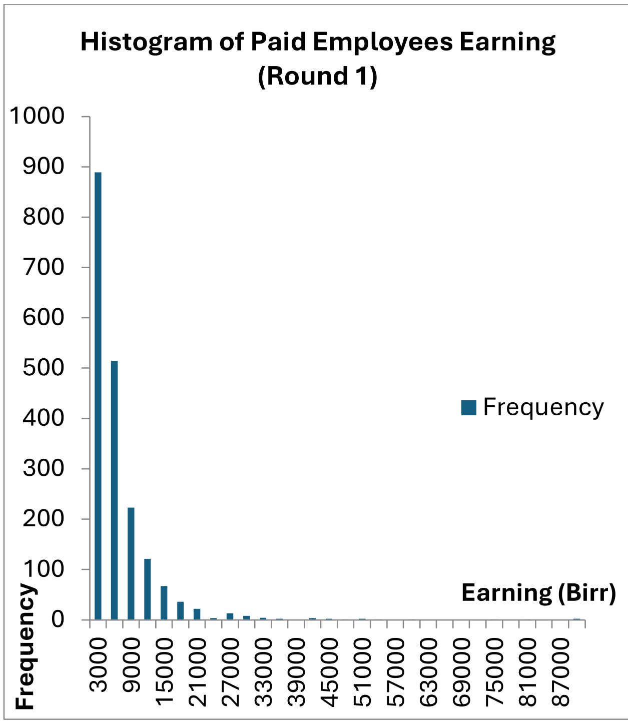
| | |
|---|---|
| **7** | Please indicate the level of congestion on the route you take to your work location.<br>0 = Never<br>1 = Rarely<br>2 = Sometimes<br>3 = Often<br>4 = Always |
| **For Private Transport Users (Questionnaire Type B)** | |
| **4** | Please State your type of Car?<br>0 = Benzene<br>1 = Napthalene<br>2 = Electric<br>3 = Not Applicable |
| **5** | How many kilometers does your car travel per litter/charge? (Responder Response) |
| | How many kilometers does your car travel per litter/charge?<br>0 = Benzene<br>1 = Napthalene<br>2 = Electric<br>3 = Not Applicable |
| **6** | How do you charge your vehicle?<br>0 = Not Applicable<br>1 = Fast Charging<br>2 = Slow Charging |
| **7** | Can you roughly estimate how much time it has taken you during your commute? (Responder Response) |
| **8** | At what time did you start your commute?<br>0 = 5:00 AM- 6:00 AM<br>1 = 6:01 AM- 7:00 AM<br>2 = 7:01 AM- 8:00 AM |

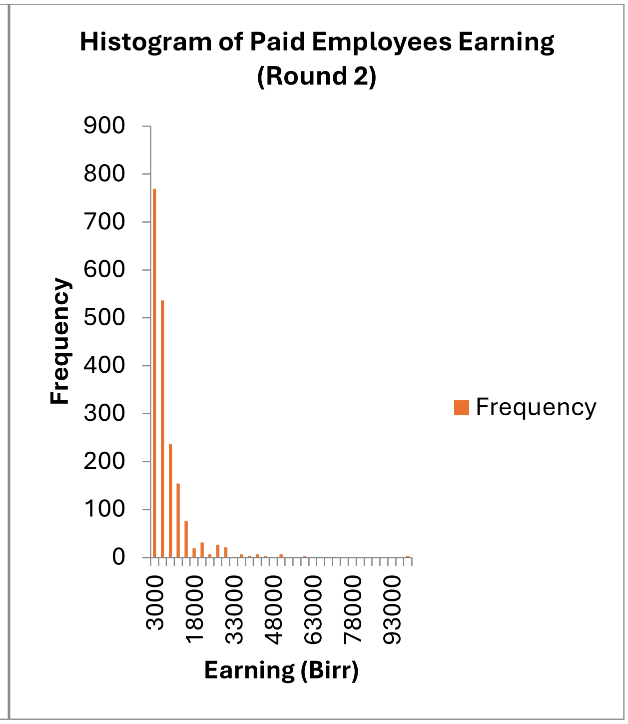
| | |
|---|---|
| | 3 = 8:01 AM- 9:00 AM |
| **9** | Please indicate the level of congestion on the route you take to your work location.<br>0 = Never<br>1 = Rarely<br>2 = Sometimes<br>3 = Often<br>4 = Always |
| **Part IV: Questions about recent trip to work** | |
| **Question Number** | Variables and Codes |
| **1-6** | Consider you are taking a recent trip to work. Which option would you prefer?<br>1 = A<br>2 = B |
| **Part IV: Questions about recent trip to work** | |
| **Question Number** | Variables and Codes |
| **-** | Please rate how difficult the survey was for you.<br>0 = Very Easy<br>1 = Easy<br>2 = Neutral<br>3 = Difficult<br>4 = Very Difficult |

# Appendix B: Questionnaire & Design

## Appendix B1: Inputs for Question Design

Addis Ababa City Income Distribution (ESS Census 2022)



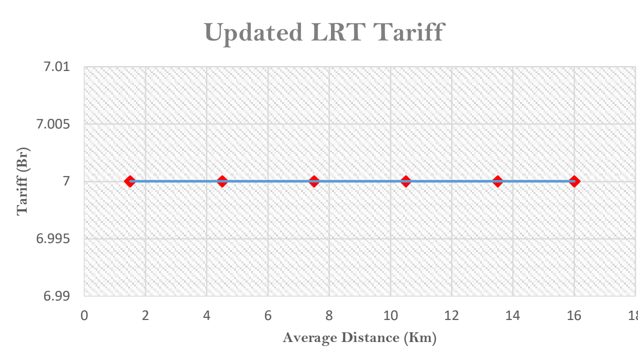




### Tariff of Various Methods

**LRT**

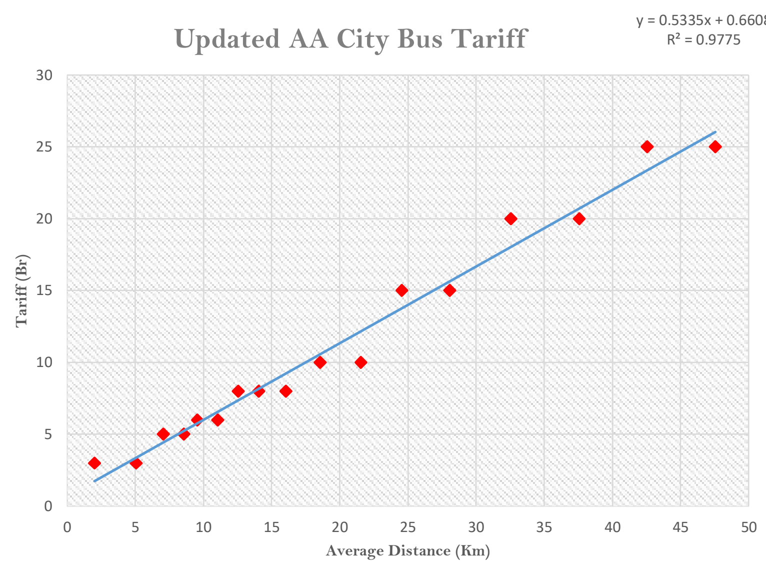
It had flat tariff regardless of the distance.

| Tariff as amended in January of 2023 | | | |
|---|---|---|---|
| Distance (Km) | | Average Distance (Km) | Updated Tariff (Birr) |
| 0 | 3 | 1.5 | 7 |
| 3.01 | 6 | 4.505 | 7 |
| 6.01 | 9 | 7.505 | 7 |
| 9.01 | 12 | 10.505 | 7 |



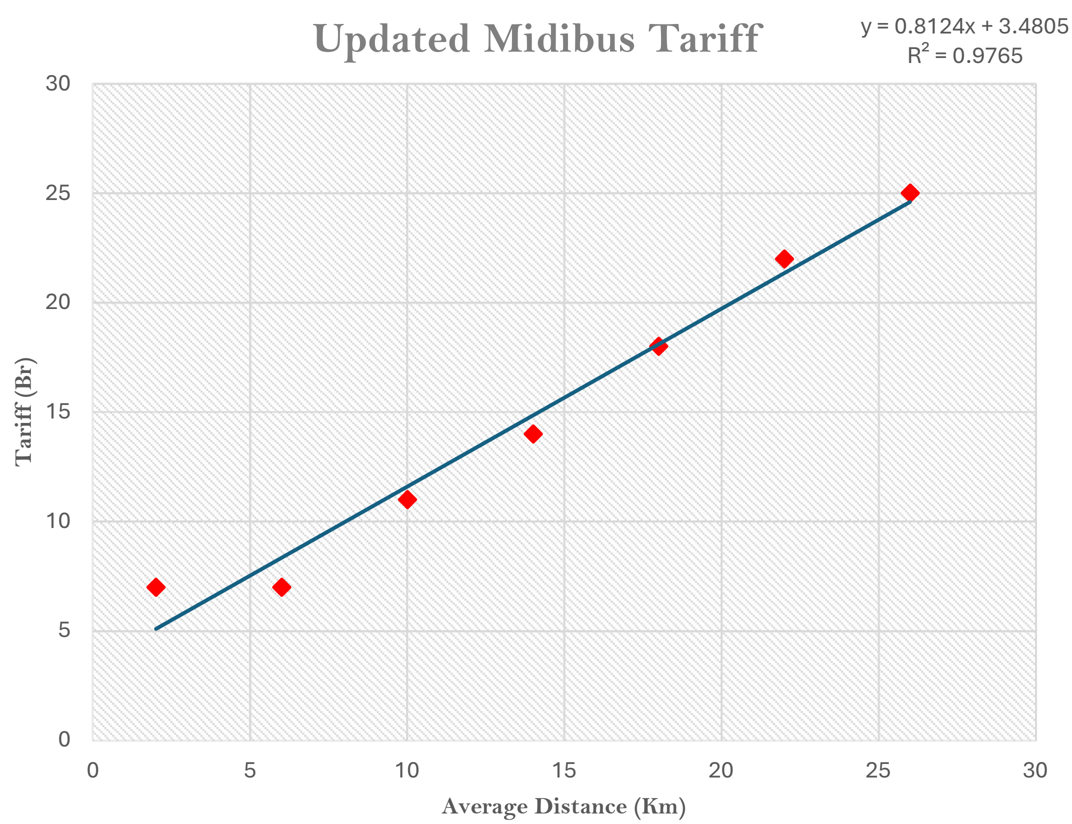
# City Bus

| Tariff as amended in January of 2023 | | | |
|---|---|---|---|
| Distance (Km) | | Average Distance (Km) | Updated Tariff (Birr) |
| 0 | 4 | 2 | 3 |
| 4.1 | 6 | 5.05 | 3 |
| 6.1 | 8 | 7.05 | 5 |
| 8.1 | 9 | 8.55 | 5 |
| 9.1 | 10 | 9.55 | 6 |
| 10.1 | 12 | 11.05 | 6 |
| 12.1 | 13 | 12.55 | 8 |
| 13.1 | 15 | 14.05 | 8 |
| 15.1 | 17 | 16.05 | 8 |
| 17.1 | 20 | 18.55 | 10 |
| 20.1 | 23 | 21.55 | 10 |
| 23.1 | 26 | 24.55 | 15 |
| 26.1 | 30 | 28.05 | 15 |
| 30.1 | 35 | 32.55 | 20 |
| 35.1 | 40 | 37.55 | 20 |
| 40.1 | 45 | 42.55 | 25 |
| 45.1 | 50 | 47.55 | 25 |

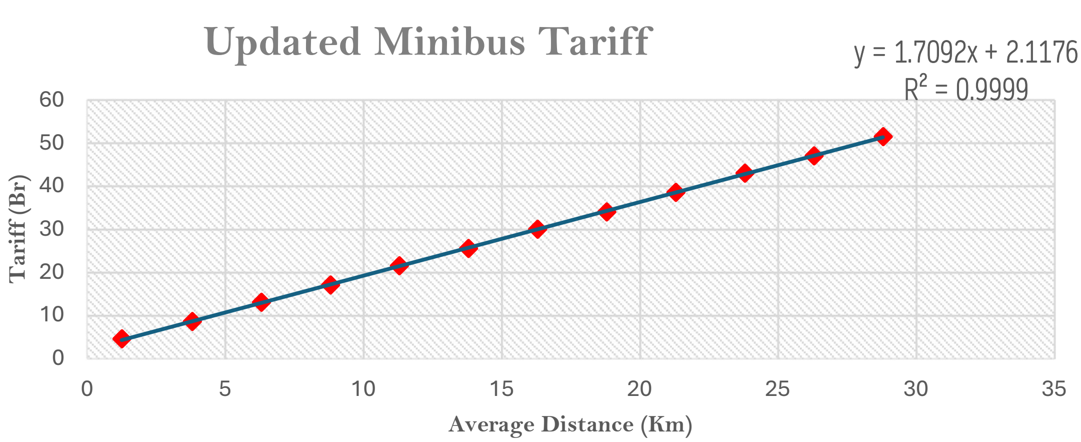
## Midi Bus

| Tariff as amended in October of 2023 | | | |
|---|---|---|---|
| Distance (Km) | | Average Distance (Km) | Updated Tariff (Birr) |
| 0 | 4 | 2 | 7 |
| 4.01 | 8 | 6.005 | 7 |
| 8.01 | 12 | 10.005 | 11 |
| 12.01 | 16 | 14.005 | 14 |
| 16.01 | 20 | 18.005 | 18 |
| 20.01 | 24 | 22.005 | 22 |
| 24.01 | 28 | 26.005 | 25 |

## Mini-Bus

| Tariff as amended in October of 2023 | | | |
|---|---|---|---|
| Distance (Km) | | Average Distance (Km) | Updated Tariff (Birr) |
| 0 | 2.5 | 1.25 | 4.5 |
| 2.6 | 5 | 3.8 | 8.5 |
| 5.1 | 7.5 | 6.3 | 13 |
| 7.6 | 10 | 8.8 | 17 |
| 10.1 | 12.5 | 11.3 | 21.5 |
| 12.6 | 15 | 13.8 | 25.5 |
| 15.1 | 17.5 | 16.3 | 30 |
| 17.6 | 20 | 18.8 | 34 |
| 20.1 | 22.5 | 21.3 | 38.5 |
| 22.6 | 25 | 23.8 | 43 |
| 25.1 | 27.5 | 26.3 | 47 |
| 27.6 | 30 | 28.8 | 51.5 |



## Ride-Sharing Services

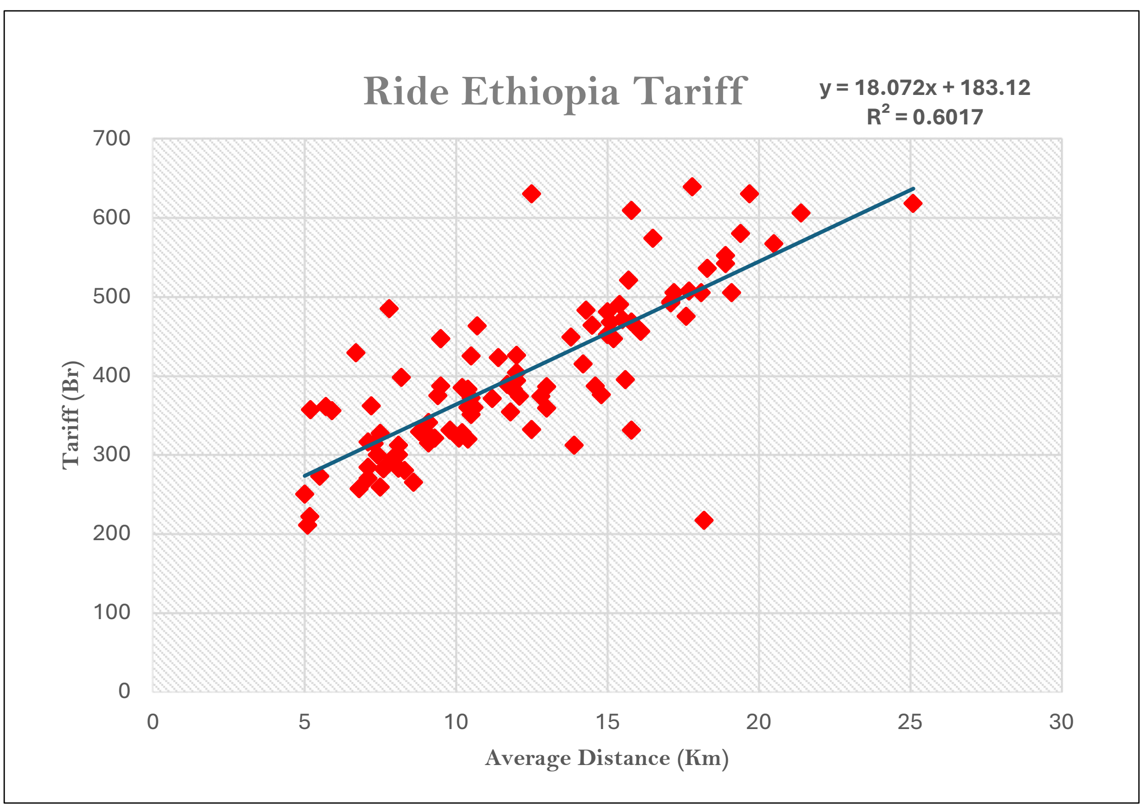
| Trip prices with the Ride app as of January 25, 2024. | | |
|---|---|---|
| **Route** | **Distance (Km)** | **Prices (Birr)** |
| ሃና ማርያም - ሳሪስ አቦ / Hana Mariyam - Saris Abo | 5.1 | 211 |
| ጎሮ - መገናኛ / Goro - Megenagna | 5.5 | 273 |
| ቀጨኔ - ፒያሳ - መርካቶ / Kechene - Piassa - Merkato | 5.179 | 222 |
| ለገሀር - 4 ኪሎ - ሽሮ ሜዳ / Legehar - 4 Kilo - Shiromeda | 7.1 | 284 |
| መገናኛ - 6 ኪሎ - ሽሮሜዳ / Megenagna - 6 Kilo - Shiromeda | 7.4 | 300 |
| ላፍቶ - ቄራ - ሜክሲኮ / Lafto - Kera - Mexico | 8.1 | 300 |
| ለገሀር - ቀለመቀርቅ ት/ቤት - ድል በር / Legehar - Kelemewerk School - Dil Ber | 8.6 | 265 |
| ሜክሲኮ - መካኒሳ - ኃይሌ ጋርመንት / Mexico - Mekanisa - Haile Garment | 10.2 | 328 |
| ቤላ - 4 ኪሎ - መርካቶ / Bela - 4 Kilo - Merkato | 10.7 | 463 |
| ለገሀር - 4 ኪሎ - ጉራራ / Legehar - 4 Kilo - Gurara | 10.4 | 320 |
| መገናኛ - 4 ኪሎ - መርካቶ / Megenagna - 4 Kilo - Merkato | 13.9 | 312 |
| አስኮ አዲሱ ሰፈር - መሳለሚያ - ፒያሳ / Asko Addisu Sefer - Mesalemia - Piassa | 10.4 | 360 |
| መገናኛ - 6 ኪሎ - አዲሱ ገበያ / Megenagna - 6 Kilo - Addisu Gebeya | 9.2 | 321 |
| ፒያሳ - ፓስተር - ሚኪሊላንድ / Piassa - Paster - Mikililand | 7.2 | 362 |
| ኮልፌ - ልደታ - ለገሀር / Kolfe - Lideta - Legehar | 7.1 | 316 |
| ቦሌ - 4 ኪሎ - መርካቶ / Bole - 4 Kilo - Merkato | 10.1 | 321 |
| ቀራንዮ - 18 ማዞሪያ - መርካቶ / Keraneyo - 10 Mazoria - Merkato | 15.5 | 471 |
| ቀራንዮ - ዋቢ ሸበሌ - ምኒልክ አደባባይ / Keraneyo - Wabi Shebele - Menelik Adebabay | 7.5 | 327 |
| ቄራ - ፒያሳ - አዲሱ ገበያ / Kera - Piassa - Addisu Gebeya | 9.5 | 387 |
| አስኮ ሳንሱሲ - መድሃኔዓለም ት/ቤት - መርካቶ / Asko Sansusi - Medhanealem School - Merkato | 21.4 | 606 |

| Route | Distance (Km) | Prices (Birr) |
|---|---|---|
| ካራ ቆሬ - ጦር ሃይሎች ሆስፒታል - ሜክሲኮ (ልዩ) / Kara Kore - Tor Hailoch Hospital - Mexico (Special) | 5.7 | 361 |
| ለገሀር - ጦር ኃይሎች - ዊንጌት / Legehar - Tor Hailoch - Winget | 9.1 | 315 |
| መገናኛ - 4 ኪሎ - ጉራራ / Megenagna - 4 Kilo - Gurara | 8.1 | 312 |
| አለም ገና ሚካኤል - ጀሞ - መካኒሳ / Alem Gena Michael - Jemo - Mekanisa | 15 | 452 |
| ዊንጌት - ጦር ሀይሎች - አየር ጤና / Winget - Tor Hailoch - Ayer Tena | 17.2 | 505 |
| 6 ኪሎ - ኦሎምፒያ - ቄራ / 6 Kilo - Olympia - Kera | 7.9 | 295 |
| ድል በር - ሩፋኤል - መርካቶ / Del Ber - Rufael - Merkato | 15.8 | 609 |
| ቦሌ ሚካኤል - ግቢ ገብርኤል - ሽሮ ሜዳ / Bole Michael - Gebi Gebriel - Shiro Meda | 11.2 | 371 |
| ቦሌ ብራስ ክሊኒክ - ፒያሳ / Bole Brass Clinic - Piassa | 9.3 | 321 |
| ጦር ኃይሎች - ግቢ ገብርኤል - ምኒልክ / Tor Hailoch - Gebi Gebriel - Menelik | 5.2 | 357 |
| ሳንሱሲ - መድሀኔዓለም ት/ቤት - ፒያሳ / Sansusi - Medhanealem School - Piassa | 5.9 | 356 |
| ሰፈራ - መካኒሳ - ሜክሲኮ / Sefera - Mekanisa - Mexico | 6.7 | 429 |
| መካኒሳ ቆሬ - መርካቶ / Mekanisa Kore - Merkato | 9.8 | 331 |
| ገርጂ - 22 ማዞሪያ - 4 ኪሎ / Gerji - 22 Mazoriya - 4 Kilo | 8.8 | 329 |
| ላምበረት - 6 ኪሎ - መርካቶ / Lamberet - 6 Kilo - Merkato | 15.2 | 447 |
| ጀርመን አደባባይ - ተግባረ ዕድ - መርካቶ / German Adebabay - Tegbare Ed - Merkato | 7.5 | 259 |
| ሃና ማርያም - መካኒሳ - ሜክሲኮ / Hana Mariyam - Mekanisa - Mexico | 11.9 | 383 |
| አለም ባንክ - ጦር ኃይሎች - ሜክሲኮ (ልዩ) / Alem Bank - Tor Hailoch - Mexico (Special) | 9.1 | 341 |
| ካራ ቆሬ - ጦር ኃይሎች - መርካቶ / Kara Kore - Tor Hailoch - Merkato | 15.6 | 395 |
| አንፎ ሜዳ - ጦር ኃይሎች - ለገሀር / Anfo Meda - Tor Hailoch - Legehar | 10.6 | 360 |
| ኮተቤ ገብርኤል - መገናኛ - 4 ኪሎ / Kotebe Gebriel - Megenagna - 4 Kilo | 12.5 | 332 |
| ቤተል - ጦር ኃይሎች - መርካቶ / Bethel - Tor Hailoch - Merkato | 15 | 481 |

| Route | Distance (Km) | Prices (Birr) |
|---|---|---|
| ጎሮ - መገናኛ - ሜክሲኮ / Goro - Megenagna - Mexico | 12 | 404 |
| ቦሌ - ፒያሳ - አዲሱ ገበያ / Bole - Piassa - Addisu Gebeya | 13.8 | 449 |
| ሃና ማርያም - መገናኛ - ለገሀር / Hana Mariam - Megenagna - Legehar | 12.8 | 374 |
| አየር ጤና - ጦር ኃይሎች - ፒያሳ / Ayer Tena - Tor Hailoch - Piassa | 10.5 | 372 |
| መገናኛ - የተባበሩት - ሰሚት ኮንዶሚኒየም / Megenagna - Yetebaberut - Summit Condominium | 13 | 359 |
| ጀሞ - ደሴ ሆቴል - መርካቶ / Jemo - Dessie Hotel - Merkato | 8.3 | 280 |
| መገናኛ - አያት - ጨፌ ኮንዶሚኒየም / Megenagna - Ayat - Chefe Condominium | 12.1 | 374 |
| መርካቶ - ጦር ኃይሎች - አለም ባንክ / Merkato - Tor Hailoch - Alem Bank | 15.8 | 331 |
| ካራ ቆሬ - ጦር ሃይሎች ሆስፒታል - ለገሀር / Kara Kore - Tor Hailoch Hospital - Legehar | 6.8 | 257 |
| አለም ባንክ - ጦር ሀይሎች - ፒያሳ / Alem Bank - Tor Hailoch - Piassa | 11.4 | 423 |
| ቤተል - ጦር ሀይሎች - ለገሀር / Bethel - Tor Hailoch - Legehar | 8.2 | 398 |
| ቦሌ - ጃክሮስ - ሰሚት ኮንዶሚኒየም / Bole - Jakros - Summit Condominium | 12 | 394 |
| ቁስቋም - 5 ኪሎ - መርካቶ / Kusqwam - 5 Kilo - Merkato | 18.3 | 536 |
| ገርጂ - ሰንሻይን - መርካቶ / Gerji - Sunshine - Merkato | 14.2 | 415 |
| ጀሞ - መካኒሳ - ለገሀር / Jemo - Mekanisa - Legehar | 10.5 | 351 |
| መገናኛ - አያት - አባኪሮስ አደባባይ / Megenagna - Ayat - Abakiros Adebabay | 14.6 | 387 |
| መካኒሳ ቆሬ - ምኒልክ አደባባይ / Mekanisa Kore - Menelik Adebabay | 7.3 | 314 |
| ቤተል - ጦር ኃይሎች - ፒያሳ / Bethel - Tor Hailoch - Piassa | 9.4 | 375 |
| አለም ባንክ - ጦር ኃይሎች - ለገሀር / Alem Bank - Tor Hailoch - Legehar | 10.2 | 385 |
| ኮተቤ መምህራን ኮሌጅ - ፒያሳ / Kotete Memeheran College - Piassa | 11.8 | 354 |
| አየር ጤና - ኃይሌ ጋርመንት - ሳሪስ አቦ / Ayer Tena - Haile Garment - Saris Abo | 15.8 | 468 |
| ቦሌ ቡልቡላ - ቦሌ ሚካኤል - መገናኛ / Bole Bulbula - Bole Michael - Megenagna | 7.6 | 282 |

| Route | Distance (Km) | Prices (Birr) |
|---|---|---|
| መገናኛ - ጦር ኃይሎች - አየር ጤና / Megenagna - Tor Hailoch - Ayer Tena | 5 | 250 |
| ፒያሳ - ሳርቤት - ጀሞ / Piassa - Sar Bet - Jemo | 12 | 426 |
| ሳሪስ አቦ - ግቢ ገብርኤል - ሽሮ ሜዳ / Saris Abo - Gebi Gebriel - Shiro Meda | 14.5 | 464 |
| ካራ - መገናኛ - ለገሀር / Kara - Megenagna - Legehar | 9.5 | 447 |
| ካራ - መገናኛ - ለገሀር / Kara - Megenagna - Legehar | 9.5 | 447 |
| አጃምባ - ጦር ኃይሎች - ፒያሳ / Ajamba - Tor Hailoch - Piassa | 14.3 | 483 |
| መገናኛ - ጣፎ - ሚሽን / Megenagna - Tafo - Mission | 14.8075 | 376 |
| ቃሊቲ - ሳሪስ - ለገሀር / Kaliti - Saris - Legehar | 15.4 | 490 |
| 4 ኪሎ - አዲሱ ገበያ - እንጦጦ ማርያም / 4 Kilo - Addisu Gebeya - Entoto Maryam | 8.1 | 283 |
| 4 ኪሎ - መገናኛ - ሰሚት / 4 Kilo - Megenagna - Summit | 13 | 386 |
| ኬንተሪ - አየር ጤና - ሜክሲኮ / Kenteri - Ayer Tena - Mexico | 15.7 | 521 |
| መገናኛ - ቦሌ - ሀይሌ ጋርመንት / Megenagna - Bole - Haile Garment | 17.6 | 475 |
| ሰሚት ኮንዶሚኒየም - መገናኛ - ለገሀር / Summit Condominium - Megenagna - Legehar | 16.1 | 456 |
| ጀሞ - ጥቁር አንበሳ ት/ቤት - 6 ኪሎ / Jemo - Tikur Anbassa School - 6 Kilo | 15.1 | 468 |
| ካራ - 4 ኪሎ - መርካቶ / Kara - 4 Kilo - Merkato | 7.8 | 485 |
| ቦሌ ቡልቡላ - ስታዲየም - ፒያሳ / Boly bulbula - Stadium - Piassa | 11.7 | 389 |
| ፒያሳ - ሳንሱሲ - ድሬ ሶሎሊያ / Piassa - Sansusi - Dire Sololiya | 12.5 | 630 |
| ፒያሳ - አባ ኪሮስ አደባባይ / Piassa - Aba Kiros Adebabay | 17.7 | 507 |
| ለቡ ሙዚቃ ሰፈር - ቄራ - መርካቶ / Lebu Muzika Sefer - Kera - Merkato | 7.1 | 270 |
| ቦሌ ሚሊኒየም - ፒያሳ - ሳንሱሲ / Bole Millenium - Piassa - Sansusi | 10.5 | 425 |
| አያት ጨፌ - መገናኛ - ለገሀር / Ayat Chefe - Megenagna - Legehar | 16.5 | 574 |
| ጀሞ 2 - ጀርመን አደባባይ - መገናኛ / Jemo 2 - German Adebabay - Megenagna | 19.4 | 580 |

| Route | Distance (Km) | Prices (Birr) |
|---|---|---|
| የካ አባዶ 13 - መገናኛ - ፒያሳ / Yeka Abado 13 / Megenagna - Piassa | 18.1 | 505 |
| መገናኛ - ፒያሳ - ሳንሱሲ / Megenagna - Piassa - Sansusi | 10.4 | 383 |
| ቃሊቲ - ጎተራ - መርካቶ / Kaliti - Gotera - Merkato | 18.2 | 217 |
| ታጠቅ ኬላ - ፊሊ ዶሮ - መርካቶ / Tatek Kela - Fili Doro - Merkato | 18.9 | 542 |
| መገናኛ - ጎሮ - ቂሊንጦ / Megenagna - Goro - Kilinto | 19.1 | 505 |
| አያት ጨፌ - መገናኛ - 6 ኪሎ / Ayat Chefe - Megenagna - 6 Kilo | 17.1 | 492 |
| የካ አባዶ ጂ7 - መገናኛ - ሜክሲኮ / Yeka Abado - Megenagna - Mexico | 18.9 | 552 |
| መገናኛ - ገርጂ መብራት ሀይል - ቱሉ ዲምቱ / Megenagna - Gerji Mebrat Hail - Tulu Dimtu | 25.1 | 618 |
| ፒያሳ - መገናኛ - ሰሚት ኮንዶሚኒየም / Piassa - Megenagna - Summit Condominium | 17.1 | 494 |
| መገናኛ - አባ ኪሮስ - ለገዳዲ / Megenagna - Aba Kiros - Legedadi | 19.7 | 630 |
| ሰሚት ኮንዶሚኒየም - መገናኛ - መርካቶ / Summit Condominium - Megenagna - Merkato | 20.5 | 567 |
| ለገሀር - ጎተራ - አቃቂ / Legehar - Gotera - Akaki | 17.8 | 639 |



**Pilot Study**

| ID | Mode Choice | Average Distance (Km) | Travel Cost (Br) | Travel Time (min) | ID | Mode Choice | Average Distance (Km) | Travel Cost (Br) | Travel Time (min) |
|---|---|---|---|---|---|---|---|---|---|
| **2A** | **CAR** | 10.2 | 300 | 30 | **1A** | **PT** | 1.25 | 5 | 10 |
| **2C** | **CAR** | 4.8 | 37.3 | 10 | **1B** | **PT** | 24 | 10 | 30 |
| **3D** | **CAR** | 18.7 | 96.8 | 60 | **1C** | **PT** | 4.8 | 10 | 20 |
| **4C** | **CAR** | 13.1 | 208.9 | 40 | **1D** | **PT** | 2.4 | 5 | 15 |
| **4D** | **CAR** | 15.4 | 108.7 | 90 | **2B** | **PT** | 12.9 | 35 | 45 |
| **5A** | **CAR** | 9.3 | 61.8 | 40 | **2D** | **PT** | 9.9 | 20 | 150 |
| **6B** | **CAR** | 2.4 | 18.6 | 15 | **3A** | **PT** | 11 | 30 | 75 |
| **6D** | **CAR** | 19.4 | 130 | 60 | **3B** | **PT** | 2.6 | 5 | 15 |
| **7A** | **CAR** | 7.9 | 68.2 | 30 | **3C** | **PT** | 11.5 | 30 | 60 |
| **7B** | **CAR** | 10.3 | 66.6 | 34 | **4A** | **PT** | 17.5 | 42 | 90 |
| **9A** | **CAR** | 3.9 | 33.6 | 25 | **4B** | **PT** | 8.1 | 35 | 90 |
| **9B** | **CAR** | 12.4 | 160.5 | 40 | **5B** | **PT** | 8.2 | 20 | 45 |
| **9D** | **CAR** | 9.3 | 100 | 30 | **5C** | **PT** | 4.1 | 10 | 25 |
| **10A** | **CAR** | 28.5 | 276.6 | 63 | **5D** | **PT** | 11.6 | 20 | 30 |
| **10B** | **CAR** | 18.9 | 172.7 | 90 | **6A** | **PT** | 17.2 | 35 | 80 |
| **10D** | **CAR** | 6.6 | 51.2 | 60 | **6C** | **PT** | 7 | 30 | 60 |
| **CAR** | **Min** | **2.40** | **18.64** | **10.00** | **7C** | **PT** | 4.2 | 15 | 50 |
| | **Average** | **11.94** | **118.23** | **44.81** | **7D** | **PT** | 12.2 | 40 | 90 |
| | **Max** | **28.50** | **300.00** | **90.00** | **8A** | **PT** | 15.7 | 30 | 65 |

| | | | | |
|---|---|---|---|---|
| **8B** | **PT** | 4.7 | 25 | 40 |
| **8C** | **PT** | 22.6 | 55 | 105 |
| **8D** | **PT** | 15.6 | 35 | 90 |
| **9C** | **PT** | 13.6 | 35 | 75 |
| **10C** | **PT** | 15 | 45 | 90 |
| **PT** | **Mean** | **1.25** | **5.00** | **10.00** |
| | **Average** | **10.74** | **25.92** | **60.21** |
| | **Max** | **24.00** | **55.00** | **150.00** |

**As of September 29, 2023 the price of**

**Benzene = 77.65 ETB**

**Diesel = 79.75 ETB**

**Analysis on March 27, 2024**

## Appendix B2: General Questionnaire

**መጋቢት ፳፻፲፮**

**ውድ ተሳታፊዎች፣**

ይህ መጠይቅ በአዲስ አበባ ዩኒቨርሲቲ የቴክኖሎጂ ኢንስቲትዩት በሲቪል እና ኢንቫይሮመንታል ምሕንድስና ትምህርት ክፍል ለሚሰጠው የመንገድ እና ትራንፖርቴሽን ድኅረ ምረቃ ፕሮግራም ማሟያ ለሚደረግ ጥናት ታስቦ የተዘጋጀ ነው። የጥናቱ ዋና ዓላማም በመዲናችን በአዲስ አበባ የሚገኙ ሠራተኞች ከመኖሪያ ቦታቸው ወደ መሥሪያ ቦታቸው በሚያደርጉት ጉዞ የሚወስድባቸውን ጊዜ በገንዘብ መተመን ነው። ይህም ዘርፈ ብዙ ጠቀሜታዎች ይኖሩታል። በተለይም የትራንስፖርት ውሳኔዎች ለሚያስፈልጋቸው ጥብቅ ጉዳዮች ጠቀሜታው የጎላ ነው። ስለዚህ ይህንን ዓላማ ለማሳካት ይረዳን ዘንድ መጠይቆቹን **በአግባቡ እንዲመልሱልን** በትህትና እንጠይቃለን። እንዲሁም ግልጽ ያልሆነልዎ ወይም እንዲብራራልዎ የሚሹት ጉዳይ ካለ እባክዎ መጠይቁን ያቀረበውን አካል ይጠይቁ። ለሚሰጡት ማንኛውም ምላሽ **ሚስጢራዊነቱ የተጠበቀና ለምርምር አገልግሎት** ብቻ የሚውል መሆኑን ከወዲሁ ልናረጋግጥልዎ እንወዳለን።

ስለትብብርዎ በቅድሚያ እናመሰግናለን!!!

ከሰላምታ ጋር፡

**አቶ ኪዳነማርያም አሉላ**

*የመንገድ እና ትራንፖርቴሽን ድህረ ምረቃ ፕሮግራም ተመራማሪ*

**<u>አማካሪዎች፡</u>**

**፩. ዶ/ር ፍጹም ተከሉ**

**፪. ዶ/ር አቤል ከበደ**

# <u>ክፍል አንድ፥ የማንጠሪያ ጥያቄዎች</u>

*እንኳን በደህና መጡ! በዚህ ክፍል ለጥናቱ ውጤት አመርቂነት ይረዳ ዘንድ ከዚህ ቀጥሎ ያሉትን ጥያቄዎች ይመልሱልን ዘንድ በትህትና እንጠይቃለን፡፡*

፩. በአሠሪዎ (በመንግስት ወይንም በግል መሥሪያ ቤት) የሚቀርቡ የትራስንፖርት አገልግሎት ተጠቃሚ ነዎት?

ተጠቃሚ ነኝ ☐ አልጠቀምም ☐

ከላይ ለተጠየቀው ጥያቄ ምላሽዎ

**ተጠቃሚ ከሆኑ ➔ ስለነበረን ጊዜ ከልብ እናመሰግናለን ! ! ! ምርጫ ያላቸውን ሰዎች ብቻ ነው ለዚህ መጠይቅ የምንፈልገው፡፡**

ተጠቃሚ ካልሆኑ ➔ እባክዎ መጠይቁን መሙላት ይቀጥሉ፡፡

፪. ወርሃዊ ገቢዎ ስንት ነው? *(ከዚህ ቀጥለው ካሉት ምድቦች ይበልጥ የሚገልጸውን ይምረጡ)*

**ከብር 5,000 በታች** ☐

**5,001- 15,000 ብር** ☐

**15,001 -25,000 ብር** ☐

**25,001- 35,000 ብር** ☐

**35,001-45,000 ብር** ☐

**ከብር 45,001 በላይ** ☐

ከዚህ በመቀጠል ጠያቂው መጠይቁን መሙላት እንዲቀጥሉ አልያም እንዲያቆሙ መመሪያ ይሰጥዎታል፡፡ ይህም የሆነው ከእያንዳንዱ የገቢ ምድቦች በቂ የሆነ ናሙና ለመውሰድ ያስችለን ዘንድ ነው፡፡ ስለቀና ትብብርዎ በድጋሚ ልናመሰግንዎ እንወዳለን፡፡

## ክፍል ሁለት፡ ማሕበረሰብ አዘል መረጃ

*በዚህ ክፍል ከእርስዎ ጋር ተያያዥነት ያላቸውን አንዳንድ ጥያቄዎች ይመልሱልን ዘንድ በትህትና እንጠይቃለን፡፡*

፩. ጾታዎ ምንድን ነው?

ወንድ ☐ ሴት ☐

፪. በየትኛው የእድሜ ክልል ውስጥ ይገኛሉ?

18 - 28 ዓመት ☐ 29 - 39 ዓመት ☐ 40 -50 ዓመት ☐ 51- 60 ዓመት ☐ ከ 60 ዓመት በላይ ☐

፫. እስከአሁን የትኛውን የትምህርት ደረጃ አጠናቀዋል?

ከ8ኛ ክፍል በታች ☐ ከ8ኛ - 12ኛክፍል ☐ ዲፕሎማ ☐

የመጀመሪያ ዲግሪ ☐ የማስተርስ ዲግሪ ☐ የማስተርስ ዲግሪ በላይ ☐

፬. ለምን አይነት ድርጅት እየሠሩ ይገኛሉ?

ለመንግስት መሥሪያ ቤት ☐ ለመንግስት የልማት ድርጅት (አየር መንገድ፣ ኢትዮ ቴሌኮም) ☐ ለመንግስታዊ ያልሆኑ መሥሪያ ቤቶች (የግል ድርጅት) ☐ የግል (የራስ) ሥራ ☐

፭. የትዳር ሁኔታዎን ይምረጡ?

ያላገባ ☐ ያገባ ☐ ባለቤቱ(ዋ) የሞተበት/ባት ☐ ከባለቤቱ(ዋ) የተፋታ/ታች ☐

፰. የቤተሰብዎን ጠቅላላ ወርሃዊ ገቢ ስንት ነው? *(ከዚህ ቀጥለው ካሉት ምድቦች ይበልጥ የሚገልጸውን ይምረጡ)*

ከብር 3,000 በታች ☐ 3,001-8,000 ብር ☐ 8,001-13,000 ብር ☐

13,001 -18,000 ብር ☐ 18,001-23,000 ብር ☐ 23,001-28,000 ብር ☐

28,001-33,000 ብር ☐ 33,001-38,000 ብር ☐ 38,001-43,000 ብር ☐

43,001-48,000 ብር ☐ 48,001-53,000 ብር ☐ 53,001-58,000 ብር ☐

ከብር 58,001 በላይ ☐

፺. የልጆችዎ ብዛት ስንት ነው?

ምንም የለኝም ☐ አንድ ☐ ከሁለት-አራት ☐ ከአራት በላይ ☐

## <u>ክፍል ሦሥት፡ በቅርብ ስላደረጓቸው ጉዞዎች ተያያዥነት ያላቸው ጥያቄዎች</u>

*በዚህ ክፍል እርስዎ በቅርቡ ከመኖሪያ ቤትዎ ወደ መሥሪያ ቤትዎ ስላደረጓቸው ጉዞዎች ጋር ተያያዥነት ያላቸውን አንዳንድ ጥያቄዎች ይመልሱልን ዘንድ በትህትና እንጠይቃለን።*

<u>ማሳሰቢያ</u>፡ በቅርቡ ያደረጉት ጉዞ ከማንኛውም አጣዳፊ ሁኔታዎች የሌሉበት መሆን አለበት። ድንገት አጣዳፊ ጉዞ አድርገው ከሆነ ከእርሱ በፊት ስላደረጉት የዘወትር ጉዞ በማሰብ እነዚህን ጥያቄዎች ይመልሱ።

፩. የጉዞ መነሻዎ የት ነበር? (የመኖሪያ ሰፈርዎ ልዩ ስም) ______________________________

፪. የጉዞ መዳረሻዎ የት ነበር? (የመሥሪያ አካባቢዎ ልዩ ስም) ______________________________

፫. በቅርብ ያደርጉትን ጉዞ በየትኛው የትራንስፖርት አማራጭ የሆነ ነው? (አንድ አማራጭ ብቻ ይምረጡ)

ቀላል ባቡር ☐ ከተማ አውቶቢስ (አንበሳ/ሸገር) ☐ የህዝብ ትራንስፖርት (ሃይገር/ቅጥቅጥ) ☐

ሚኒ ባስ ታክሲ ☐ የላዳ ትራንስፖርት ☐ ራይድ/ፈረስ/ያንጎ..... ☐

የግል መኪና ☐

፬. በቅርብ ላደረጉት ጉዞ በግምት ምን ያህል ብር አወጡ? *(የጠዋት ጉዞዎን ብቻ)*

የተለያዩ የትራንስፖርት አገልግሎቶች ተጠቃሚ ከሆኑ ________________ ብር

የግል መኪና ተጠቃሚ ከሆኑ መኪናዎ በሊትር ስንት ኪሎሜትር ይሄዳል? ለናፍጣ ___________ ለቤንዚን ___________

መኪናዎ የኤሌክትሪክ ከሆነ በአንድ ቻርጅ ስንት ኪሎሜትር ይሄዳል? ________________

፭. በቅርብ ባደረጉት ጉዞ በግምት ምን ያህል ሰዓት ፈጀብዎት? *(የጠዋት ጉዞዎን ብቻ)*

________________ ሰዓት ከ________________ ደቂቃ

፮. ከመኖሪያ ሰፈርዎ ጉዞዎን በየትኛው የሰዓት ጊዜ ውስጥ ጀምሩ ?

ከ 11፡00 ሰዓት እስከ 12፡00 ሰዓት ☐ ከ12፡01 ሰዓት እስከ 1፡00 ሰዓት ☐ ከ1፡01 ሰዓት እስከ 2፡00 ሰዓት ☐ ከ2፡01 ሰዓት እስከ 3፡00 ሰዓት ☐

፯. ከመኖሪያ ሰፈርዎ እስከ መሥሪያ ቤትዎ ያለውን የትራፊክ መጨናነቅ ደረጃ እንዴት ይገልጹታል?

በጭራሽ ☐ ከስንት አንዴ ☐ አንዳንዴ ☐ ብዙ ጊዜ ☐ ሁልጊዜ ☐

## Appendix B3: Choice set for Public Transports

ለባቡር፣አውቶቢስ፣ የህዝብ ትራንስፖርት እና ታክሲ ተጠቃሚዎች ብቻ

### ክፍል አራት፡ የምርጫ ጥያቄዎች

*በዚህ ክፍል ከጉዞዎ ጋር ተያያዝነት ያላቸውን አንዳንድ ጥያቄዎች ይመልሱልን ዘንድ በትህትና እንጠይቃለን፡፡*

**እባክዎ ከቤትዎ እስከመሥሪያ ቤትዎ የሚያደርጉትን ጉዞ እያደረጉ እንደሆነ ያስቡ፡፡ ከዚህ በታች ከቀረቡት ሁለት አማራጮች የቱን ጉዞ ይወስዱ ይሆን?** (እባክዎ ምርጫዎን በማክበብ ይግለጹ)

### የምርጫ ጥያቄ ቁጥር 01

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | 45 ደቂቃ | ሁለት ሰዓት<br>(120 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 30 | 10 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

### የምርጫ ጥያቄ ቁጥር 02

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) | 45 ደቂቃ |
| የጉዞው ጠቅላላ ወጪ (ብር) | 30 | 80 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## ምርጫ ጥያቄ ቁጥር 03

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) | ሁለት ሰዓት<br>(120 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 80 | 30 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## የምርጫ ጥያቄ ቁጥር 04

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | 45 ደቂቃ | ሁለት ሰዓት<br>(120 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 80 | 30 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## የምርጫ ጥያቄ ቁጥር 05

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) | 45 ደቂቃ |
| የጉዞው ጠቅላላ ወጪ (ብር) | 10 | 80 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## የምርጫ ጥያቄ ቁጥር 06

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት ተኩል (90 ደቂቃ) | ሁለት ሰዓት (120 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 80 | 10 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ? ◌ ◌

**በመጨረሻም የዚህን መጠይቅ ክብደት እንዴት ይገመግሙታል?**

**በጣም ቀላል** ☐ **ቀላል** ☐ **መካከለኛ** ☐ **ከባድ** ☐ **በጣም ከባድ** ☐

## Appendix B4: Choice set for Private Transports

ለላዳ ፣ ራይድ እና የግል መኪና ተጠቃሚዎች ብቻ

**ክፍል አራት፡ የምርጫ ጥያቄዎች**

*በዚህ ክፍል ከጉዞዎ ጋር ተያያዝነት ያላቸውን አንዳንድ ጥያቄዎች ይመልሱልን ዘንድ በትህትና እንጠይቃለን።*

**እባክዎ ከቤትዎ እስከመሥሪያ ቤትዎ የሚያደርጉትን ጉዞ እያደረጉ እንደሆነ ያስቡ። ከዚህ በታች ከቀረቡት ሁለት አማራጮች የቱን ጉዞ ይወስዱ ይሆን?** (እባክዎ ምርጫዎን በማክበብ ይግለጹ)

**የምርጫ ጥያቄ ቁጥር 01**

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | ግማሽ ሰዓት (30 ደቂቃ) | አንድ ሰዓት ተኩል (90 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 450 | 100 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

**የምርጫ ጥያቄ ቁጥር 02**

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት (60 ደቂቃ) | ግማሽ ሰዓት (30 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 310 | 450 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## ምርጫ ጥያቄ ቁጥር 03

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት<br>(60 ደቂቃ) | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 450 | 100 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## የምርጫ ጥያቄ ቁጥር 04

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | ግማሽ ሰዓት<br>(30 ደቂቃ) | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 450 | 310 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## የምርጫ ጥያቄ ቁጥር 05

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | አንድ ሰዓት ተኩል<br>(90 ደቂቃ) | ግማሽ ሰዓት<br>(30 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 100 | 310 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ?

## **የምርጫ ጥያቄ ቁጥር 06**

| የጉዞ አማራጭ | ሀ | ለ |
|---|---|---|
| በጉዞ የሚፈጀው ሰዓት | ግማሽ ሰዓት (30 ደቂቃ) | አንድ ሰዓት (60 ደቂቃ) |
| የጉዞው ጠቅላላ ወጪ (ብር) | 310 | 100 |

ከእነዚህ ሁለት አማራጮች የቱን ይመርጣሉ? ◯ ◯

**በመጨረሻም የዚህን መጠይቅ ክብደት እንዴት ይገመግሙታል?**

**በጣም ቀላል** ☐ **ቀላል** ☐ **መካከለኛ** ☐ **ከባድ** ☐ **በጣም ከባድ** ☐

## Appendix B5: Online Survey

Addis Ababa University

አዲስ፡አበባ፡ዩኒቨርሲቲ

SEEK WISDOM, ELEVATE YOUR INTELLECT AND SERVE HUMANITY !

# በአዲስ አበባ ከተማ የሚገኙ ሠራተኞች ከመኖሪያ ቤታቸው ወደ መሥሪያ ቦታቸው በትራንስፖርት የሚያሳልፉትን ጊዜ በገንዘብ ለመተመን የተዘጋጀ፡፡

**ውድ ተሳታፊዎች፣**

ይህ መጠይቅ በአዲስ አበባ ዩኒቨርሲቲ የቴክኖሎጂ ኢንስቲትዩት
በሲቪል እና ኢንቫይሮመንታል ምሕንድስና ትምህርት ክፍል ውስጥ ለሚሰጠው የመንገድ እና ትራንስፖርት ድኅረ ምረቃ ፕሮግራም ማሟያ ለሚደረግ
ጥናት ታስቦ የተዘጋጀ ነው፡፡ የጥናቱ ዋና ዓላማም በመዲናችን በአዲስ አበባ የሚገኙ ሠራተኞች ከመኖሪያ ቦታቸው ወደ መሥሪያ ቦታቸው
በሚያደርጉት ጉዞ የሚወስድባቸውን ጊዜ በገንዘብ መተመን ነው፡፡ ይህም ዘርፈ ብዙ ጠቀሜታዎች ይኖሩታል፡፡ በተለይም የትራንስፖርት
ውሳኔዎች ለሚያስፈልጋቸው ጥብቅ ጉዳዮች ጠቀሜታው የጎላ ነው፡፡ ስለዚህ ይህንን ዓላማ ለማሳካት ይረዳን ዘንድ መጠይቆቹን **በአግባቡ እንዲመልሱልን** በትህትና እንጠይቃለን፡፡ ለሚሰጡት ማንኛውም ምላሽ **ሚስጢራዊነቱ የተጠበቀና ለምርምር አገልግሎት** ብቻ የሚውል መሆኑን ከወዲሁ ልናረጋግጥልዎ እንወዳለን፡፡ በመጨረሻም ግልጽ ያልሆነልዎ፣ እንዲብራራልዎ የሚሹት ጉዳይ ወይንም ለማንኛውም አስተያየት ከታች ባለው በኢሜይል አድራሻ መላክ ይችላሉ፡፡

ስለትብብርዎ በቅድሚያ
እናመሰግናለን!!!

https://docs.google.com/forms/d/e/1FAIpQLSffODUEjNZCMvzM8Runer3LpVybx_evcmBkbJvt5O3sCAoIIQ/viewform?usp=sf_link

## Appendix C: Demographic Breakdown of Respondents

| Variables | Pilot Survey | Main Survey |
|---|---|---|
| **Gender** | | |
| Male | 75.0% | 71.0% |
| Female | 25.0% | 29.0% |
| **Age** | | |
| 18 to 28 | 40.0% | 49.6% |
| 29 to 39 | 33.0% | 38.8% |
| 40 to 50 | 15.0% | 9.3% |
| 51 to 60 | 8.0% | 2.0% |
| 60 and older | 5.0% | 0.3% |
| **Education** | | |
| Below 8th grade | 3.0% | 1.7% |
| 8th - 12th grade | 3.0% | 4.9% |
| Diploma | 3.0% | 4.9% |
| Degree | 43.0% | 65.8% |
| Masters | 33.0% | 19.7% |
| Above Masters | 18.0% | 2.9% |

| Variables | Pilot Survey | Main Survey |
|---|---|---|
| **Employment** | | |
| Government | 28.0% | 22.0% |
| Public Enterprise | 3.0% | 2.6% |
| Private | 45.0% | 60.3% |
| Self-Employed | 25.0% | 15.1% |
| **Martial Status** | | |
| Single | 55.0% | 65.2% |
| Married | 30.0% | 33.9% |
| Widowed | 10.0% | 0.6% |
| Divorced | 5.0% | 0.3% |
| **Household Income** | | |
| Less than 3,000 | 8.0% | 1.4% |
| 3,001-8,000 | 8.0% | 10.1% |
| 8,001-13,000 | 8.0% | 11.9% |
| 13,001-18,000 | 5.0% | 12.8% |
| 18,001-23,000 | 10.0% | 9.6% |
| 23,001-28,000 | 8.0% | 6.7% |
| 28,001-33,000 | 13.0% | 8.4% |

| Variables | Pilot Survey | Main Survey |
|---|---|---|
| 33,001-38,000 | 13.0% | 4.6% |
| 38,001-43,000 | 5.0% | 4.1% |
| 43,001-48,000 | 5.0% | 3.8% |
| 48,001-53,000 | 3.0% | 7.2% |
| 53,001-58,000 | 5.0% | 1.4% |
| Greater than 58,001 | 13.0% | 18.0% |
| **Children** | | |
| None | 60.0% | 74.8% |
| One | 5.0% | 8.4% |
| Two-Four | 35.0% | 15.9% |
| More than Four | 0.0% | 0.9% |
| **Mode of Transportation** | | |
| LRT | 0.0% | 0.3% |
| City Bus | 8.0% | 11.3% |
| Midi-Bus | 5.0% | 3.8% |
| Mini-Bus Taxi | 48.0% | 59.7% |
| Lada Transport | 5.0% | 1.7% |
| Ride Hailing Services | 3.0% | 7.0% |

| Variables | Pilot Survey | Main Survey |
|---|---|---|
| Private Car | 33.0% | 16.2% |
| **Trip Departure Time** | | |
| 5:00-6:00 AM | NA | 6.7% |
| 6:01-7:00 AM | NA | 29.6% |
| 7:01-8:00 AM | NA | 34.2% |
| 8:01-9:00 AM | NA | 29.6% |
| **Level of Congestion** | | |
| Never | 10.0% | 6.4% |
| Rarely | 10.0% | 9.0% |
| Sometimes | 13.0% | 25.5% |
| Often | 45.0% | 37.4% |
| Always | 23.0% | 21.7% |

# Appendix D: Survey Outputs

## Appendix D1: Pilot Survey

### Aggregate Model

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | -0.279 | 0.153 | -1.83 | -136.1516 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.00379 | 0.000986 | -3.85 | | | | |
| BETA_TT | -0.0164 | 0.00314 | -5.22 | | 0.164 (16.4%) | 278.30 | 288.74 |
| VOT_Birr/min | **4.33** | | | | | | |
| VOT_Birr/hr | **259.63** | | | | | | |

**Group 1 (Below 3,000 Birr)**

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | 0.121 | 0.515 | 0.235 | -14.89627 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.0141 | 0.0114 | -1.24 | | | | |
| BETA_TT | -0.0216 | 0.0135 | -1.6 | | 0.0758 (7.58%) | 35.79254 | 39.3267 |
| VOT_Birr/min | **1.53** | | | | | | |
| VOT_Birr/hr | **91.91** | | | | | | |

**Group 2 ( 3,001-8,000 Birr)**

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | -0.0325 | 0.492 | -0.0661 | -13.79727 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.00487 | 0.00273 | -1.78 | | | | |
| BETA_TT | -0.0135 | 0.00978 | -1.38 | | 0.00972 (0.9%) | 33.59455 | 37.12871 |
| VOT_Birr/min | **2.77** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **VOT_Birr/hr** | **166.32** | | | | | | |

**Group 3( 8,001-13,000 Birr)**

| **Parameters** | **Value** | **Rob. Standard Error** | **Rho-square t-test** | **Final log likelihood** | **Goodness to fit** | | |
|---|---|---|---|---|---|---|---|
| **ASC_ Second** | -0.376 | 0.678 | -0.554 | -8.281056 | ***Adjusted $R^2$*** | ***AIC*** | ***BIC*** |
| **BETA_TC** | -0.0352 | 0.0161 | -2.19 | | | | |
| **BETA_TT** | -0.0373 | 0.0179 | -2.09 | | 0.0853 (8.53%) | 22.56211 | 26.09627 |
| **VOT_Birr/min** | **1.06** | | | | | | |
| **VOT_Birr/hr** | **63.58** | | | | | | |

**Group 4 ( 13,001-18,000 Birr)**

| **Parameters** | **Value** | **Rob. Standard Error** | **Rho-square t-test** | **Final log likelihood** | **Goodness to fit** | | |
|---|---|---|---|---|---|---|---|
| **ASC_ Second** | -1.35 | 0.48 | -2.82 | -12.609 | ***Adjusted $R^2$*** | ***AIC*** | ***BIC*** |
| **BETA_TC** | 0.00141 | 0.00257 | 0.547 | | | | |
| **BETA_TT** | 0.0292 | 0.01 | 2.91 | | 0.0617(6.17%) | 31.21966 | 34.75382 |
| **VOT_Birr/hr** | **-** | | | | | | |

**Group 5 ( 18,001-23,000 Birr)**

| **Parameters** | **Value** | **Rob. Standard Error** | **Rho-square t-test** | **Final log likelihood** | **Goodness to fit** | | |
|---|---|---|---|---|---|---|---|
| **ASC_ Second** | -0.91 | 0.514 | 1.77 | -11.40306 | ***Adjusted $R^2$*** | ***AIC*** | ***BIC*** |
| **BETA_TC** | -0.00687 | 0.00441 | -1.56 | | | | |
| **BETA_TT** | -0.0168 | 0.0107 | -1.57 | | 0.134 (13.4%) | 28.80612 | 32.34028 |
| **VOT_Birr/min** | **2.45** | | | | | | |
| **VOT_Birr/hr** | **146.72** | | | | | | |

Group 6 ( 23,001-28,000 Birr)

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | 1.7 | 0.627 | 2.72 | -9.511933 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.00538 | 0.00363 | -1.48 | | | | |
| BETA_TT | -0.0493 | 0.0147 | -3.35 | | 0.248 (24.8%) | 25.02387 | 28.55803 |
| VOT_Birr/min | **9.16** | | | | | | |
| VOT_Birr/hr | **549.81** | | | | | | |

Group 7 ( 28,001-33,000 Birr)

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | -0.179 | 0.527 | -0.341 | -12.53395 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.00552 | 0.00258 | -2.14 | | | | |
| BETA_TT | -0.0185 | 0.00982 | -1.89 | | 0.0662(6.62%) | 31.0679 | 34.60206 |
| VOT_Birr/min | **3.35** | | | | | | |
| VOT_Birr/hr | **201.09** | | | | | | |

Group 8 ( 33,001-38,000 Birr)

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | -0.519 | 0.537 | -0.966 | -8.68882 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.0344 | 0.0141 | -2.43 | | | | |
| BETA_TT | -0.0697 | 0.0178 | -3.91 | | 0.297(29.7%) | 23.37765 | 26.911 |
| VOT_Birr/min | **2.03** | | | | | | |
| VOT_Birr/hr | **121.57** | | | | | | |

Group 9( 38,001-43,000 Birr)

| Parameters | Value | Rob. Standard Error | Rho-square t-test | Final log likelihood | Goodness to fit | | |
|---|---|---|---|---|---|---|---|
| ASC_ Second | 0.198 | 0.555 | 0.357 | -8.63660 | *Adjusted $R^2$* | *AIC* | *BIC* |
| BETA_TC | -0.00486 | 0.00311 | -1.56 | | | | |

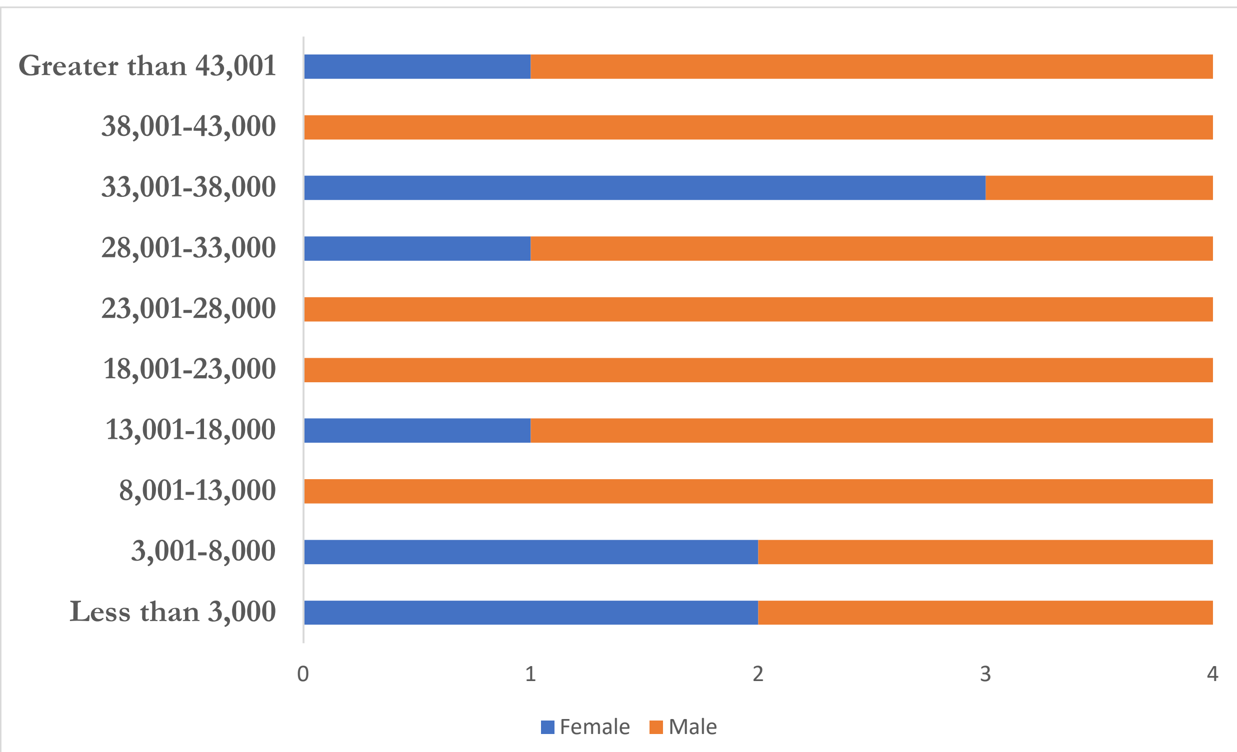
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **BETA_TT** | -0.0433 | 0.0177 | -2.44 | | 0.3(30%) | 23.27321 | 26.80737 |
| **VOT_Birr/min** | **8.91** | | | | | | |
| **VOT_Birr/hr** | **534.57** | | | | | | |

**Group 10( Above 43,001 Birr)**

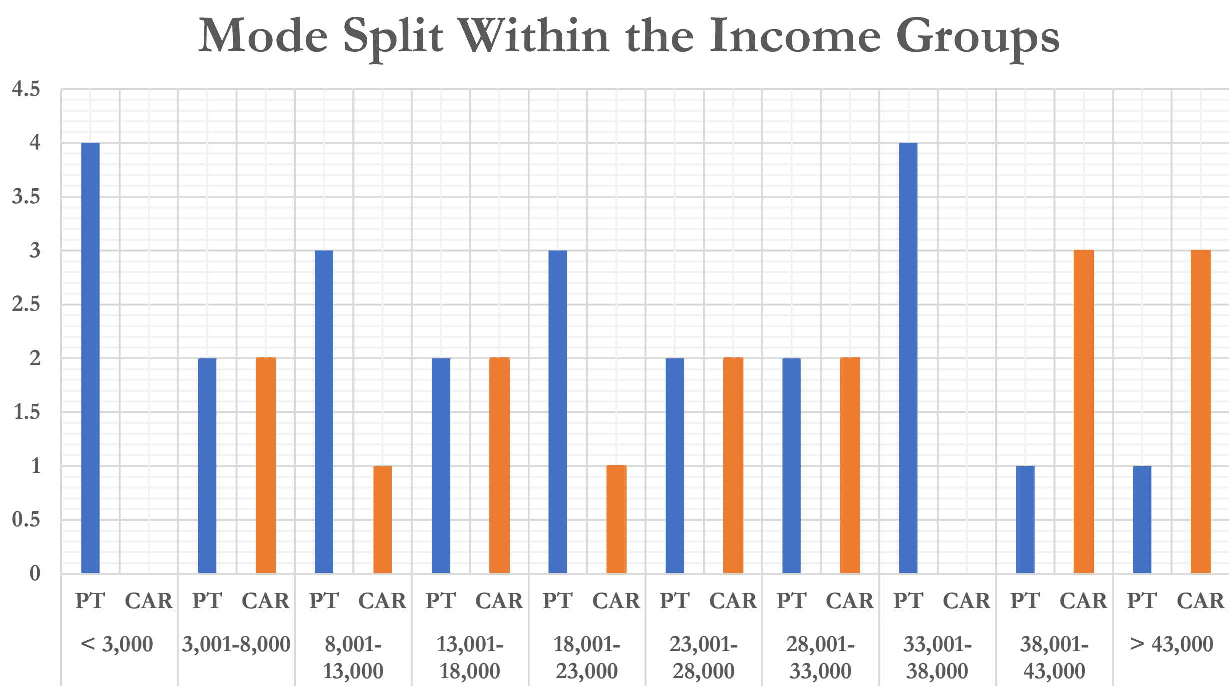
| **Parameters** | **Value** | **Rob. Standard Error** | **Rho-square t-test** | **Final log likelihood** | **Goodness to fit** | | |
|---|---|---|---|---|---|---|---|
| **ASC_ Second** | -0.643 | 0.696 | -0.925 | -7.59467 | ***Adjusted $R^2$*** | ***AIC*** | ***BIC*** |
| **BETA_TC** | -0.00314 | 0.00148 | -2.12 | | | | |
| **BETA_TT** | -0.0432 | 0.0137 | -3.15 | | 0.363(36.3%) | 21.18935 | 24.72351 |
| **VOT_Birr/min** | **13.76** | | | | | | |
| **VOT_Birr/hr** | **825.48** | | | | | | |

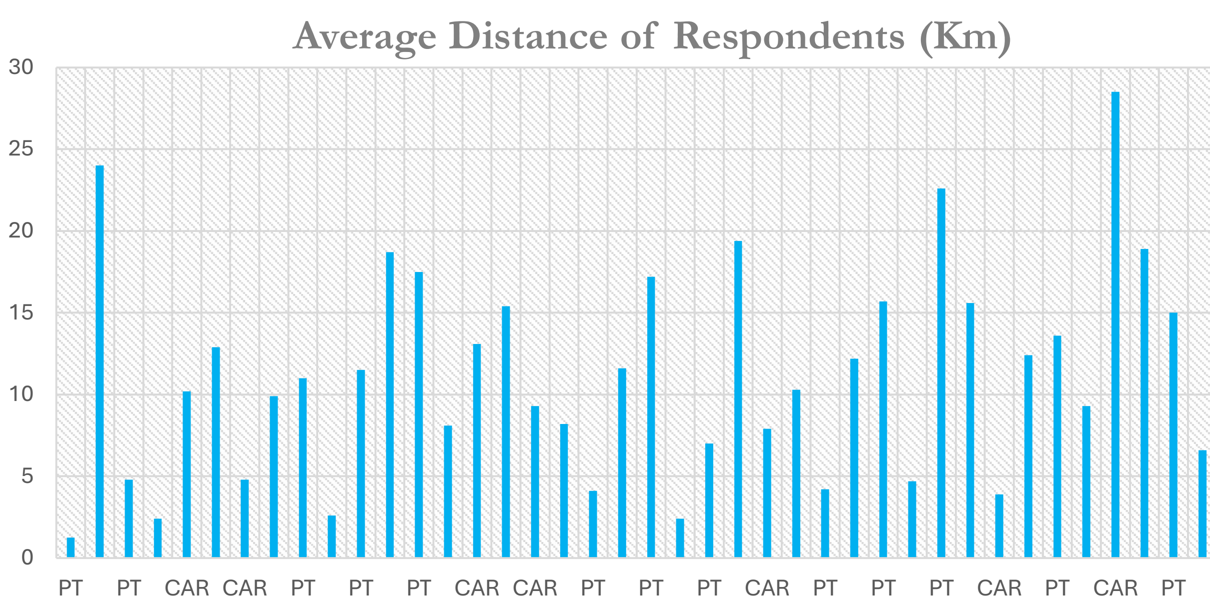
## Basic Socio-Demographic Informations

**Gender**



**Mode**


Mode Split Within the Income Groups
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
PT CAR PT CAR PT CAR PT CAR PT CAR PT CAR PT CAR PT CAR PT CAR PT CAR
< 3,000
3,001-8,000
8,001-13,000
13,001-18,000
18,001-23,000
23,001-28,000
28,001-33,000
33,001-38,000
38,001-43,000
> 43,000


Average Distance of Respondents (Km)
30
25
20
15
10
5
0
PT PT CAR CAR PT PT PT CAR CAR PT PT PT CAR PT PT PT CAR PT CAR PT

## Appendix D2: Main Survey

**First Alternative Utility Function:**

$$
\begin{aligned}
V_{\text{FIRST}} = {} & \text{ASC\_FIRST} + \beta_{\text{TIME}} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST}} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Low}} \cdot \text{Low\_Income} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Low}} \cdot \text{Low\_Income} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Middle}} \cdot \text{Middle\_Income} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Middle}} \cdot \text{Middle\_Income} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Male}} \cdot \text{Male} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Male}} \cdot \text{Male} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Over\_60}} \cdot \text{Over\_60} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Over\_60}} \cdot \text{Over\_60} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Widowed}} \cdot \text{Widowed} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Widowed}} \cdot \text{Widowed} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Divorced}} \cdot \text{Divorced} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Divorced}} \cdot \text{Divorced} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_LRT}} \cdot \text{LRT} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_LRT}} \cdot \text{LRT} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Lada}} \cdot \text{Lada} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Lada}} \cdot \text{Lada} \cdot \text{FIRST\_TC\_SCALED} \\
& + \beta_{\text{TIME\_Ride\_Hailing}} \cdot \text{Ride\_Hailing} \cdot \text{FIRST\_TT\_SCALED} + \beta_{\text{COST\_Ride\_Hailing}} \cdot \text{Ride\_Hailing} \cdot \text{FIRST\_TC\_SCALED}
\end{aligned} \tag{1}
$$

**Second Alternative Utility Function:**

$$
\begin{aligned}
V_{\text{SECOND}} = {} & \text{ASC\_SECOND} + \beta_{\text{TIME}} \cdot \text{SECOND\_TT} + \beta_{\text{COST}} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Low}} \cdot \text{Low\_Income} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Low}} \cdot \text{Low\_Income} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Middle}} \cdot \text{Middle\_Income} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Middle}} \cdot \text{Middle\_Income} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Male}} \cdot \text{Male} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Male}} \cdot \text{Male} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Over\_60}} \cdot \text{Over\_60} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Over\_60}} \cdot \text{Over\_60} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Widowed}} \cdot \text{Widowed} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Widowed}} \cdot \text{Widowed} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Divorced}} \cdot \text{Divorced} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Divorced}} \cdot \text{Divorced} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_LRT}} \cdot \text{LRT} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_LRT}} \cdot \text{LRT} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_City\_Bus}} \cdot \text{City\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Midi\_Bus}} \cdot \text{Midi\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Mini\_Bus}} \cdot \text{Mini\_Bus} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Lada}} \cdot \text{Lada} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Lada}} \cdot \text{Lada} \cdot \text{SECOND\_TC} \\
& + \beta_{\text{TIME\_Ride\_Hailing}} \cdot \text{Ride\_Hailing} \cdot \text{SECOND\_TT} + \beta_{\text{COST\_Ride\_Hailing}} \cdot \text{Ride\_Hailing} \cdot \text{SECOND\_TC}
\end{aligned} \tag{2}
$$

**Reference Groups:**

- Household Income: High Income
- Gender: Female
- Age Group: 18-28
- Marital Status: Single
- Current Main Mode: Private Car

Table 1: Model Results with VOT by Group

| Variable | Value | Rob. Std err | Rob. t-test | Rob. p-value | Sig. | VOT (Birr/hr) |
|---|---|---|---|---|---|---|
| ASC_FIRST | −3.31 | 0.405 | −8.17 | $2.22 \times 10^{-16}$ | *** | |
| BETA_COST | −0.007 29 | 0.001 29 | −5.65 | $1.57 \times 10^{-8}$ | *** | |
| BETA_TIME | −0.0334 | 0.004 42 | −7.55 | $4.31 \times 10^{-14}$ | *** | |
| Base | | | | | | 275.0 |
| **Household Income** | | | | | | |
| BETA_TIME_Low | 0.002 85 | 0.001 59 | 1.79 | 0.0731 | | |
| BETA_COST_Low | 0.000 587 | 0.001 28 | 0.461 | 0.645 | | |
| BETA_TIME_Middle | 0.005 18 | 0.001 56 | 3.32 | 0.000 892 | *** | |
| BETA_COST_Middle | −0.002 16 | 0.001 02 | −2.13 | 0.0334 | * | |
| **Gender** | | | | | | |
| BETA_TIME_Male | 0.004 01 | 0.001 35 | 2.97 | 0.002 97 | ** | |
| BETA_COST_Male | −0.000 294 | 0.001 03 | −0.287 | 0.774 | | |
| **Age groups** | | | | | | |
| BETA_TIME_Over_60 | 0.126 | 0.0146 | 8.66 | 0 | *** | |
| BETA_COST_Over_60 | −0.169 | 0.0249 | −6.78 | $1.20 \times 10^{-11}$ | *** | |
| **Marital status** | | | | | | |
| BETA_TIME_Widowed | −0.107 | 0.007 39 | −14.4 | 0 | *** | |
| BETA_COST_Widowed | 0.159 | 0.0119 | 13.4 | 0 | *** | |
| BETA_TIME_Divorced | −0.104 | 0.006 84 | −15.2 | 0 | *** | |
| BETA_COST_Divorced | 0.153 | 0.0105 | 14.5 | 0 | *** | |
| **Current main mode** | | | | | | |
| BETA_TIME_LRT | −0.119 | 0.007 26 | −16.4 | 0 | *** | |
| BETA_COST_LRT | 0.156 | 0.0109 | 14.3 | 0 | *** | |
| BETA_TIME_City_Bus | 0.0703 | 0.0420 | 1.67 | 0.0944 | † | |
| BETA_COST_City_Bus | 0.0929 | 0.0587 | 1.58 | 0.113 | | |
| BETA_TIME_Midi_Bus | −0.004 47 | 0.003 51 | −1.27 | 0.203 | | |
| BETA_COST_Midi_Bus | −0.0164 | 0.006 36 | −2.58 | 0.009 96 | ** | |
| BETA_TIME_Mini_Bus | −0.007 54 | 0.002 07 | −3.64 | 0.000 273 | *** | |
| BETA_COST_Mini_Bus | −0.0105 | 0.003 22 | −3.26 | 0.001 10 | ** | |
| BETA_TIME_Lada | 0.258 | 0.0147 | 17.5 | 0 | *** | |
| BETA_COST_Lada | −0.0817 | 0.007 27 | −11.2 | 0 | *** | |
| BETA_TIME_Ride_Hailing | −0.003 22 | 0.003 71 | −0.867 | 0.386 | | |
| BETA_COST_Ride_Hailing | $1.61 \times 10^{-5}$ | 0.001 10 | 0.0147 | 0.988 | | |

**Significance:** *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$

**Value of Time (VOT) formula:**

$$\text{VOT} = (\beta_{\text{TIME}}/\beta_{\text{COST}}) \times 60 \quad \text{(Birr/hour)}$$

**Base: An individual from the reference group, choosing Private Transport.**

| **Statistic** | **Value** |
|---|---:|
| Log-likelihood (final) | −1232.098 |
| $\rho^2$ | 0.784 |
| Adjusted $\rho^2$ | 0.78 |
| Akaike Information Criterion (AIC) | 2518.195 |
| Bayesian Information Criterion (BIC) | 2670.349 |

*Note.* The table presents goodness-of-fit measures for the estimated model. Higher $\rho^2$ values (range 0–1) indicate better model fit. Information criteria (AIC, BIC) are used for model comparison, with lower values preferred. The $\rho^2$ value of 0.78 indicates a strong model fit.

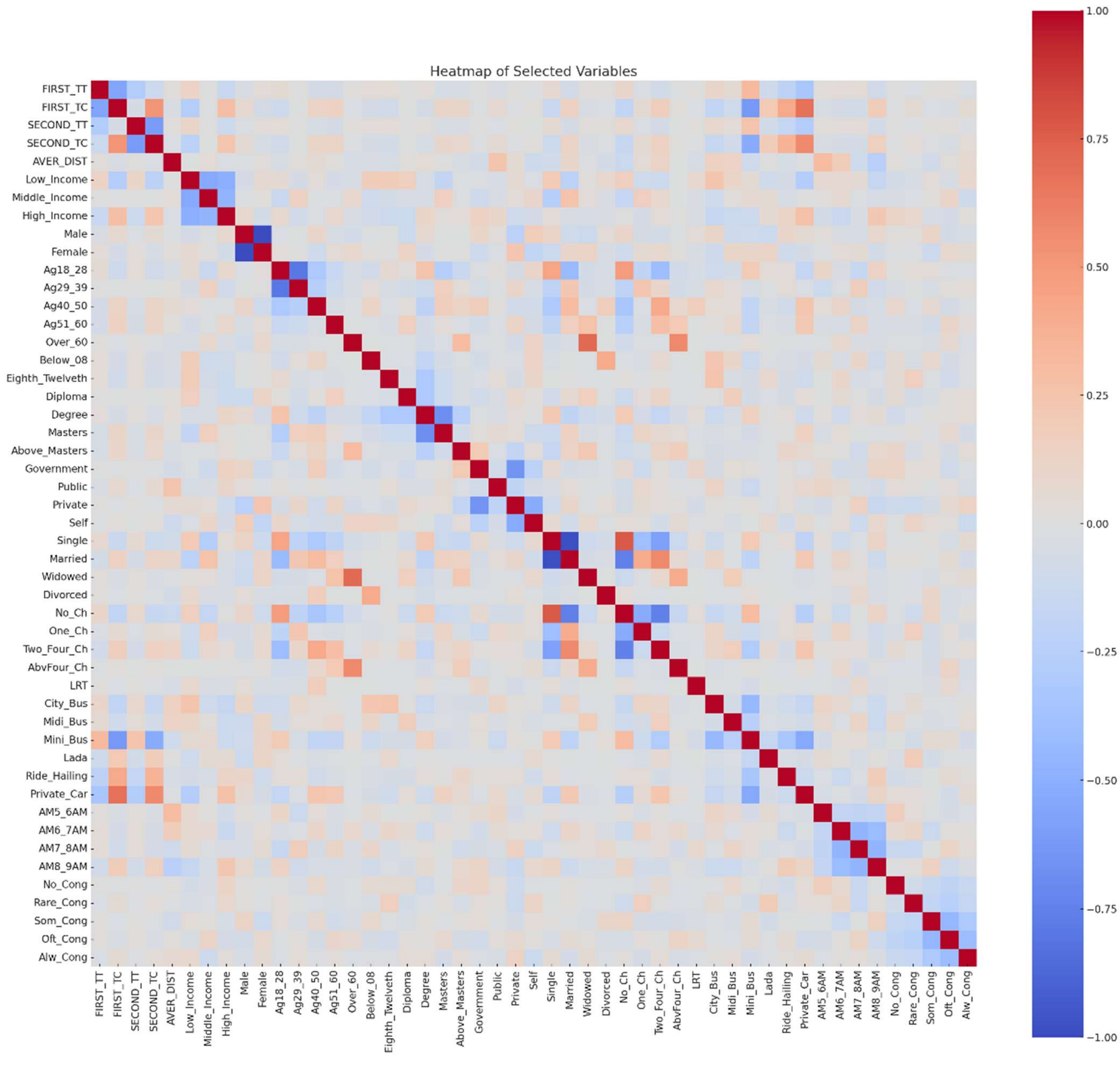


**Table: Distribution of Mode Choice by Socio-Demographic Segments**

| Household Income Group | Gender | Age Group | Marital Status | Mode of Transport | No. of Respondents |
|---|---|---|---|---|---|
| Below 3,000 | Male | 18-28 | Single | City Bus | 6 |
| Below 3,000 | Male | 18-28 | Single | Ride-Hailing | 6 |
| Below 3,000 | Male | 29-39 | Married | City Bus | 6 |
| Below 3,000 | Male | 29-39 | Single | City Bus | 6 |
| Below 3,000 | Male | 40-50 | Divorced | Mini-Bus Taxi | 6 |
| 3,001-8,000 | Female | 18-28 | Married | Mini-Bus Taxi | 6 |
| 3,001-8,000 | Female | 18-28 | Single | City Bus | 12 |
| 3,001-8,000 | Female | 18-28 | Single | Midi-Bus | 12 |
| 3,001-8,000 | Female | 18-28 | Single | Mini-Bus Taxi | 36 |
| 3,001-8,000 | Female | 18-28 | Single | Ride-Hailing | 6 |
| 3,001-8,000 | Female | 29-39 | Single | City Bus | 12 |
| 3,001-8,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 3,001-8,000 | Female | 40-50 | Single | Midi-Bus | 6 |
| 3,001-8,000 | Male | 18-28 | Married | City Bus | 6 |
| 3,001-8,000 | Male | 18-28 | Single | City Bus | 12 |
| 3,001-8,000 | Male | 18-28 | Single | Mini-Bus Taxi | 24 |
| 3,001-8,000 | Male | 29-39 | Married | City Bus | 12 |
| 3,001-8,000 | Male | 29-39 | Married | Mini-Bus Taxi | 6 |
| 3,001-8,000 | Male | 29-39 | Single | Midi-Bus | 12 |
| 3,001-8,000 | Male | 29-39 | Single | Mini-Bus Taxi | 24 |
| 3,001-8,000 | Male | 29-39 | Single | Ride-Hailing | 6 |
| 3,001-8,000 | Male | 40-50 | Single | Mini-Bus Taxi | 6 |
| 3,001-8,000 | Male | 40-50 | Single | Private Car | 6 |
| 8,001-13,000 | Female | 18-28 | Married | Mini-Bus Taxi | 6 |
| 8,001-13,000 | Female | 18-28 | Single | Mini-Bus Taxi | 60 |
| 8,001-13,000 | Female | 29-39 | Single | Mini-Bus Taxi | 12 |
| 8,001-13,000 | Male | 18-28 | Married | City Bus | 6 |
| 8,001-13,000 | Male | 18-28 | Married | Mini-Bus Taxi | 6 |
| 8,001-13,000 | Male | 18-28 | Single | City Bus | 6 |
| 8,001-13,000 | Male | 18-28 | Single | Midi-Bus | 6 |
| 8,001-13,000 | Male | 18-28 | Single | Mini-Bus Taxi | 60 |
| 8,001-13,000 | Male | 18-28 | Single | Ride-Hailing | 6 |
| 8,001-13,000 | Male | 29-39 | Married | City Bus | 6 |
| 8,001-13,000 | Male | 29-39 | Married | Mini-Bus Taxi | 6 |
| 8,001-13,000 | Male | 29-39 | Single | City Bus | 12 |
| 8,001-13,000 | Male | 29-39 | Single | Mini-Bus Taxi | 24 |
| 8,001-13,000 | Male | 29-39 | Single | Private Car | 6 |
| 8,001-13,000 | Male | 40-50 | Married | City Bus | 6 |
| 8,001-13,000 | Male | 40-50 | Married | Mini-Bus Taxi | 6 |
| 8,001-13,000 | Male | 40-50 | Married | Private Car | 6 |
| 8,001-13,000 | Male | 40-50 | Single | Light Rail Transit | 6 |
| 13,001-18,000 | Female | 18-28 | Married | Mini-Bus Taxi | 12 |
| 13,001-18,000 | Female | 18-28 | Single | Mini-Bus Taxi | 30 |
| 13,001-18,000 | Female | 29-39 | Married | Mini-Bus Taxi | 6 |
| 13,001-18,000 | Female | 29-39 | Single | Midi-Bus | 6 |
| 13,001-18,000 | Female | 29-39 | Single | Mini-Bus Taxi | 12 |
| 13,001-18,000 | Female | 51-60 | Widowed | Midi-Bus | 6 |
| 13,001-18,000 | Male | 18-28 | Single | City Bus | 12 |
| 13,001-18,000 | Male | 18-28 | Single | Mini-Bus Taxi | 60 |
| 13,001-18,000 | Male | 18-28 | Single | Ride-Hailing | 6 |
| 13,001-18,000 | Male | 29-39 | Married | City Bus | 12 |
| 13,001-18,000 | Male | 29-39 | Married | Mini-Bus Taxi | 12 |

Continued on next page

Table 1 – continued from previous page

| Household Income Group | Gender | Age Group | Marital Status | Mode of Transport | No. of Respondents |
|---|---|---|---|---|---|
| 13,001-18,000 | Male | 29-39 | Single | City Bus | 18 |
| 13,001-18,000 | Male | 29-39 | Single | Mini-Bus Taxi | 36 |
| 13,001-18,000 | Male | 29-39 | Single | Ride-Hailing | 6 |
| 13,001-18,000 | Male | 40-50 | Married | City Bus | 12 |
| 13,001-18,000 | Male | 40-50 | Married | Mini-Bus Taxi | 6 |
| 13,001-18,000 | Male | 40-50 | Married | Private Car | 6 |
| 13,001-18,000 | Male | 40-50 | Single | Mini-Bus Taxi | 6 |
| 18,001-23,000 | Female | 18-28 | Married | Mini-Bus Taxi | 6 |
| 18,001-23,000 | Female | 18-28 | Single | Mini-Bus Taxi | 18 |
| 18,001-23,000 | Female | 29-39 | Married | Midi-Bus | 6 |
| 18,001-23,000 | Female | 29-39 | Married | Mini-Bus Taxi | 12 |
| 18,001-23,000 | Female | 29-39 | Married | Private Car | 6 |
| 18,001-23,000 | Female | 29-39 | Single | Lada | 6 |
| 18,001-23,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 18,001-23,000 | Male | 18-28 | Married | Mini-Bus Taxi | 6 |
| 18,001-23,000 | Male | 18-28 | Single | City Bus | 6 |
| 18,001-23,000 | Male | 18-28 | Single | Mini-Bus Taxi | 36 |
| 18,001-23,000 | Male | 29-39 | Married | City Bus | 6 |
| 18,001-23,000 | Male | 29-39 | Married | Midi-Bus | 6 |
| 18,001-23,000 | Male | 29-39 | Married | Mini-Bus Taxi | 30 |
| 18,001-23,000 | Male | 29-39 | Single | Mini-Bus Taxi | 24 |
| 18,001-23,000 | Male | 29-39 | Single | Private Car | 6 |
| 18,001-23,000 | Male | 40-50 | Married | Mini-Bus Taxi | 12 |
| 18,001-23,000 | Male | 40-50 | Single | Private Car | 6 |
| 23,001-28,000 | Female | 18-28 | Single | Mini-Bus Taxi | 12 |
| 23,001-28,000 | Female | 29-39 | Married | Mini-Bus Taxi | 12 |
| 23,001-28,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 23,001-28,000 | Female | Above 60 | Widowed | Mini-Bus Taxi | 6 |
| 23,001-28,000 | Male | 18-28 | Married | Mini-Bus Taxi | 6 |
| 23,001-28,000 | Male | 18-28 | Single | Mini-Bus Taxi | 6 |
| 23,001-28,000 | Male | 18-28 | Single | Private Car | 6 |
| 23,001-28,000 | Male | 29-39 | Married | City Bus | 12 |
| 23,001-28,000 | Male | 29-39 | Married | Mini-Bus Taxi | 6 |
| 23,001-28,000 | Male | 29-39 | Married | Private Car | 12 |
| 23,001-28,000 | Male | 29-39 | Married | Ride-Hailing | 6 |
| 23,001-28,000 | Male | 29-39 | Single | Mini-Bus Taxi | 30 |
| 23,001-28,000 | Male | 29-39 | Single | Private Car | 6 |
| 23,001-28,000 | Male | 40-50 | Married | Midi-Bus | 6 |
| 23,001-28,000 | Male | 51-60 | Married | City Bus | 6 |
| 28,001-33,000 | Female | 18-28 | Married | Mini-Bus Taxi | 12 |
| 28,001-33,000 | Female | 18-28 | Married | Private Car | 6 |
| 28,001-33,000 | Female | 18-28 | Single | Mini-Bus Taxi | 6 |
| 28,001-33,000 | Female | 29-39 | Married | Mini-Bus Taxi | 12 |
| 28,001-33,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 28,001-33,000 | Female | 40-50 | Married | City Bus | 6 |
| 28,001-33,000 | Male | 18-28 | Married | Mini-Bus Taxi | 12 |
| 28,001-33,000 | Male | 18-28 | Single | Lada | 6 |
| 28,001-33,000 | Male | 18-28 | Single | Mini-Bus Taxi | 24 |
| 28,001-33,000 | Male | 18-28 | Single | Private Car | 6 |
| 28,001-33,000 | Male | 29-39 | Married | City Bus | 6 |
| 28,001-33,000 | Male | 29-39 | Married | Mini-Bus Taxi | 24 |
| 28,001-33,000 | Male | 29-39 | Married | Private Car | 6 |
| 28,001-33,000 | Male | 29-39 | Married | Ride-Hailing | 12 |

Continued on next page

Table 1 – continued from previous page

| Household Income Group | Gender | Age Group | Marital Status | Mode of Transport | No. of Respondents |
|---|---|---|---|---|---|
| 28,001-33,000 | Male | 29-39 | Single | Mini-Bus Taxi | 12 |
| 28,001-33,000 | Male | 40-50 | Married | Mini-Bus Taxi | 12 |
| 28,001-33,000 | Male | 40-50 | Married | Private Car | 6 |
| 33,001-38,000 | Female | 18-28 | Single | Mini-Bus Taxi | 6 |
| 33,001-38,000 | Female | 29-39 | Married | Midi-Bus | 6 |
| 33,001-38,000 | Female | 29-39 | Married | Private Car | 6 |
| 33,001-38,000 | Female | 40-50 | Married | Private Car | 6 |
| 33,001-38,000 | Male | 18-28 | Single | Midi-Bus | 6 |
| 33,001-38,000 | Male | 18-28 | Single | Mini-Bus Taxi | 24 |
| 33,001-38,000 | Male | 18-28 | Single | Private Car | 6 |
| 33,001-38,000 | Male | 18-28 | Single | Ride-Hailing | 6 |
| 33,001-38,000 | Male | 29-39 | Married | Mini-Bus Taxi | 12 |
| 33,001-38,000 | Male | 29-39 | Married | Ride-Hailing | 6 |
| 33,001-38,000 | Male | 29-39 | Single | Mini-Bus Taxi | 12 |
| 38,001-43,000 | Female | 18-28 | Married | Ride-Hailing | 6 |
| 38,001-43,000 | Female | 18-28 | Single | Lada | 6 |
| 38,001-43,000 | Female | 18-28 | Single | Mini-Bus Taxi | 12 |
| 38,001-43,000 | Female | 29-39 | Married | Mini-Bus Taxi | 6 |
| 38,001-43,000 | Female | 29-39 | Married | Private Car | 6 |
| 38,001-43,000 | Male | 18-28 | Married | Mini-Bus Taxi | 6 |
| 38,001-43,000 | Male | 18-28 | Married | Private Car | 6 |
| 38,001-43,000 | Male | 18-28 | Single | City Bus | 6 |
| 38,001-43,000 | Male | 18-28 | Single | Mini-Bus Taxi | 6 |
| 38,001-43,000 | Male | 18-28 | Single | Private Car | 6 |
| 38,001-43,000 | Male | 29-39 | Married | Private Car | 6 |
| 38,001-43,000 | Male | 40-50 | Married | Mini-Bus Taxi | 6 |
| 38,001-43,000 | Male | 51-60 | Married | Private Car | 6 |
| 43,001-48,000 | Female | 29-39 | Married | City Bus | 6 |
| 43,001-48,000 | Female | 29-39 | Married | Mini-Bus Taxi | 12 |
| 43,001-48,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 43,001-48,000 | Male | 18-28 | Single | City Bus | 6 |
| 43,001-48,000 | Male | 18-28 | Single | Mini-Bus Taxi | 18 |
| 43,001-48,000 | Male | 29-39 | Married | Mini-Bus Taxi | 6 |
| 43,001-48,000 | Male | 29-39 | Single | Private Car | 6 |
| 43,001-48,000 | Male | 29-39 | Single | Ride-Hailing | 6 |
| 43,001-48,000 | Male | 40-50 | Married | City Bus | 6 |
| 43,001-48,000 | Male | 40-50 | Married | Private Car | 6 |
| 48,001-53,000 | Female | 18-28 | Single | Mini-Bus Taxi | 6 |
| 48,001-53,000 | Female | 29-39 | Married | Private Car | 6 |
| 48,001-53,000 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| 48,001-53,000 | Male | 18-28 | Married | Mini-Bus Taxi | 6 |
| 48,001-53,000 | Male | 18-28 | Single | Mini-Bus Taxi | 60 |
| 48,001-53,000 | Male | 18-28 | Single | Private Car | 18 |
| 48,001-53,000 | Male | 18-28 | Single | Ride-Hailing | 6 |
| 48,001-53,000 | Male | 29-39 | Single | Mini-Bus Taxi | 24 |
| 48,001-53,000 | Male | 29-39 | Single | Private Car | 6 |
| 48,001-53,000 | Male | 40-50 | Married | Private Car | 12 |
| 53,001-58,000 | Female | 18-28 | Married | Lada | 6 |
| 53,001-58,000 | Female | 29-39 | Married | Mini-Bus Taxi | 6 |
| 53,001-58,000 | Male | 18-28 | Married | Private Car | 6 |
| 53,001-58,000 | Male | 18-28 | Single | City Bus | 6 |
| 53,001-58,000 | Male | 29-39 | Single | Mini-Bus Taxi | 6 |
| Above 58,001 | Female | 18-28 | Married | Mini-Bus Taxi | 6 |

Continued on next page

**Table 1 – continued from previous page**

| Household Income Group | Gender | Age Group | Marital Status | Mode of Transport | No. of Respondents |
|---|---|---|---|---|---|
| Above 58,001 | Female | 18-28 | Married | Ride-Hailing | 6 |
| Above 58,001 | Female | 18-28 | Single | Mini-Bus Taxi | 18 |
| Above 58,001 | Female | 29-39 | Married | Lada | 6 |
| Above 58,001 | Female | 29-39 | Married | Mini-Bus Taxi | 12 |
| Above 58,001 | Female | 29-39 | Married | Private Car | 12 |
| Above 58,001 | Female | 29-39 | Single | Mini-Bus Taxi | 6 |
| Above 58,001 | Female | 29-39 | Single | Private Car | 6 |
| Above 58,001 | Female | 40-50 | Married | Private Car | 12 |
| Above 58,001 | Female | 51-60 | Married | Private Car | 12 |
| Above 58,001 | Male | 18-28 | Single | Lada | 6 |
| Above 58,001 | Male | 18-28 | Single | Mini-Bus Taxi | 102 |
| Above 58,001 | Male | 18-28 | Single | Private Car | 42 |
| Above 58,001 | Male | 18-28 | Single | Ride-Hailing | 30 |
| Above 58,001 | Male | 29-39 | Married | Mini-Bus Taxi | 6 |
| Above 58,001 | Male | 29-39 | Married | Private Car | 12 |
| Above 58,001 | Male | 29-39 | Married | Ride-Hailing | 6 |
| Above 58,001 | Male | 29-39 | Single | Mini-Bus Taxi | 12 |
| Above 58,001 | Male | 29-39 | Single | Private Car | 12 |
| Above 58,001 | Male | 29-39 | Single | Ride-Hailing | 18 |
| Above 58,001 | Male | 40-50 | Married | Private Car | 18 |
| Above 58,001 | Male | 51-60 | Married | Private Car | 12 |

**Table 12. Summary of model-estimated VOT across socio-demographic segments, based on time & cost coefficient combinations.**

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 1 | 0 | 0 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 2 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 3 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 4 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 5 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **-0.104** | **-0.007** | **0** | **0** | **0** | **0.153** | **-0.011** | -0.0334 | -0.0073 | -0.1404 | 0.1352 | **-62** |
| 6 | 0 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 7 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 8 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | -0.0334 | -0.0237 | 85 |
| 9 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 10 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 11 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 12 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 13 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | -0.0334 | -0.0237 | 85 |
| 14 | 0 | 0 | 1 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 15 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 16 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 17 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 18 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 19 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | -0.0294 | -0.0237 | 74 |
| 20 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 21 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 22 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 23 | 0 | 0 | 0 | 1 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 24 | 0 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 25 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 26 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 27 | 0 | 0 | 1 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 28 | 0 | 0 | 1 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 29 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 30 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | -0.0294 | -0.0237 | 74 |
| 31 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 32 | 0 | 0 | 1 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 33 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 34 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 35 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 36 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 37 | 0 | 0 | 0 | 1 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 38 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 39 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 40 | 0 | 0 | 0 | 0 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 41 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.119** | **0** | **0** | **0** | **0** | **0.156** | -0.0334 | -0.0073 | -0.1484 | -0.1487 | **-60** |
| 42 | 0 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 43 | 0 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 44 | 0 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 45 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | -0.0334 | -0.0237 | 85 |
| 46 | 0 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 47 | 0 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **-0.107** | **0** | **0** | **0** | **0** | **0.159** | **-0.016** | -0.0334 | -0.0073 | -0.1404 | 0.1353 | **-62** |
| 48 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 49 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 50 | 0 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 51 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 52 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 53 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 54 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 55 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 56 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 57 | 0 | 0 | 0 | 0 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 58 | 0 | 0 | 0 | 0 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 59 | 0 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 60 | 0 | 1 | 1 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 61 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 62 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | 0.0184 | -0.0259 | **-43** |
| 63 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 64 | 0 | 1 | 0 | 0 | 1 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 65 | 0 | 1 | 0 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **0.258** | **-0.002** | **0** | **0** | **0** | **-0.082** | -0.0334 | -0.0073 | 0.2764 | -0.0912 | **-182** |
| 66 | 0 | 1 | 0 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 67 | 0 | 0 | 1 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 68 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 69 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 70 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 71 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | 0.0224 | -0.0259 | **-52** |
| 72 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 73 | 0 | 0 | 0 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 74 | 0 | 0 | 0 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 75 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 76 | 0 | 0 | 0 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 77 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 78 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 79 | 0 | 1 | 0 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 80 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0.126** | **-0.107** | **-0.007** | **-0.002** | **0** | **-0.169** | **0.159** | **-0.011** | -0.0334 | -0.0073 | 0.0304 | -0.0300 | **-61** |
| 81 | 0 | 0 | 1 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 82 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 83 | 0 | 0 | 1 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 84 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 85 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 86 | 0 | 0 | 0 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 87 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 88 | 0 | 0 | 0 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 89 | 0 | 0 | 0 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 90 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | 0.0224 | -0.0259 | **-52** |
| **91** | **0** | **0** | **0** | **0** | **0** | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | **-0.0334** | **-0.0073** | **0.0224** | **-0.0095** | **-142** |
| 92 | 0 | 1 | 1 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 93 | 0 | 1 | 1 | 0 | 1 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 94 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 95 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 96 | 0 | 1 | 0 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 97 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 98 | 0 | 0 | 1 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 99 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **0.258** | **-0.002** | **0** | **0** | **0** | **-0.082** | -0.0334 | -0.0073 | 0.2804 | -0.0912 | **-185** |
| 100 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 101 | 0 | 0 | 1 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 102 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 103 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 104 | 0 | 0 | 0 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 105 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 106 | 0 | 0 | 0 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 107 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 108 | 0 | 0 | 0 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 109 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 110 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | 0.0184 | -0.0259 | **-43** |
| 111 | 0 | 1 | 0 | 0 | 1 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 112 | 0 | 1 | 0 | 0 | 1 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 113 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **-0.016** | -0.0334 | -0.0073 | 0.0224 | -0.0259 | **-52** |
| 114 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 115 | 0 | 0 | 1 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 116 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 117 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 118 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 119 | 0 | 0 | 0 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 120 | 0 | 1 | 1 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 121 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **0.258** | **-0.002** | **0** | **0** | **0** | **-0.082** | -0.0334 | -0.0073 | 0.2764 | -0.0912 | **-182** |
| 122 | 0 | 1 | 1 | 1 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 123 | 0 | 1 | 0 | 0 | 0 | **0.0518** | **0** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0114 | -0.0200 | **-34** |
| 124 | 0 | 1 | 0 | 0 | 1 | **0.0518** | **0** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0184 | -0.0095 | **-117** |
| 125 | 0 | 0 | 1 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 126 | 0 | 0 | 1 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 127 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 128 | 0 | 0 | 1 | 1 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 129 | 0 | 0 | 1 | 1 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 130 | 0 | 0 | 0 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 131 | 0 | 0 | 0 | 0 | 0 | **0.0518** | **0.004** | **0** | **0** | **-0.007** | **-0.002** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | 0.0154 | -0.0200 | **-46** |
| 132 | 0 | 0 | 0 | 0 | 1 | **0.0518** | **0.004** | **0** | **0** | **0** | **-0.002** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | 0.0224 | -0.0095 | **-142** |
| 133 | 1 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 134 | 1 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 135 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 136 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 137 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 138 | 1 | 0 | 0 | 0 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 139 | 1 | 0 | 0 | 1 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 140 | 1 | 0 | 0 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 141 | 1 | 0 | 0 | 0 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 142 | 1 | 0 | 0 | 0 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 143 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 144 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 145 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 146 | 1 | 0 | 1 | 0 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 147 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 148 | 1 | 0 | 1 | 1 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 149 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 150 | 1 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 151 | 1 | 0 | 0 | 1 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 152 | 1 | 0 | 0 | 0 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 153 | 1 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **0.258** | **0** | **0** | **0** | **0** | **-0.082** | -0.0334 | -0.0073 | 0.2246 | -0.0890 | **-151** |
| 154 | 1 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 155 | 1 | 0 | 1 | 0 | 1 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 156 | 1 | 0 | 1 | 1 | 0 | **0** | **0.004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 157 | 1 | 0 | 0 | 1 | 0 | **0** | **0.004** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 158 | 1 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 159 | 1 | 1 | 1 | 0 | 0 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 160 | 1 | 1 | 1 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 161 | 1 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **0.258** | **0** | **0** | **0** | **0** | **-0.082** | -0.0334 | -0.0073 | 0.2246 | -0.0890 | **-151** |
| 162 | 1 | 1 | 0 | 0 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |
| 163 | 1 | 1 | 0 | 0 | 1 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 164 | 1 | 1 | 0 | 1 | 0 | **0** | **0** | **0** | **0** | **-0.007** | **0** | **0** | **0** | **0** | **-0.011** | -0.0334 | -0.0073 | -0.0404 | -0.0178 | 136 |

| No | HH | Gend | Age | Marr | Mode of Transport | *BETA TIME* | | | | | *BETA COST* | | | | | Base | | Total | | VOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HH | Gend | Age | Mrtl St | Mode | HH | Gendr | Age | Mrtl St | Mode | *BETA TIME* | *BETA COST* | *BETA TIME* | *BETA COST* | (Birr/hr) |
| 165 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 166 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 167 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0334 | -0.0073 | 275 |
| 168 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0.258 | 0 | 0 | 0 | 0 | -0.082 | -0.0334 | -0.0073 | 0.2286 | -0.0890 | **-154** |
| 169 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 170 | 1 | 0 | 1 | 1 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 171 | 1 | 0 | 1 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 172 | 1 | 0 | 0 | 0 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 173 | 1 | 0 | 0 | 0 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 174 | 1 | 0 | 0 | 0 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 175 | 1 | 0 | 0 | 1 | 0 | 0 | 0.004 | 0 | 0 | -0.007 | 0 | 0 | 0 | 0 | -0.011 | -0.0334 | -0.0073 | -0.0364 | -0.0178 | 123 |
| 176 | 1 | 0 | 0 | 1 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 177 | 1 | 0 | 0 | 1 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 178 | 1 | 0 | 0 | 0 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |
| 179 | 1 | 0 | 0 | 0 | 1 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0334 | -0.0073 | -0.0294 | -0.0073 | 242 |

# Appendix E: Applied Biogeme Code

## Analysis of Main SP Study

### Import necessary libraries

In [3]:
```
import biogeme
import biogeme.version as ver
# print(ver.get_text())
```

In [4]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import biogeme.biogeme as bio
import biogeme.database as db
from biogeme.expressions import Variable
from biogeme import models
from biogeme.expressions import Beta
```

### Loading dataset

In [6]:
```
data = pd.read_csv("SP Data.csv")
```

In [7]:
```
data.columns
```

Out[7]:
```
Index(['ID', 'SP', 'P_INCOME', 'SEX', 'AGE', 'EDUC', 'EMPLOY', 'MARR',
       'H_INCOME', 'CHILD', 'MODE', 'CAR_TYPE', 'DEP_TIME', 'LOC', 'FIRST_TT',
       'FIRST_TC', 'FIRST_AV', 'SECOND_TT', 'SECOND_TC', 'SECOND_AV', 'DIFF',
       'AVER_DIST', 'P_INCOME_GROUPED', 'CHOICE'],
      dtype='object')
```

In [8]:
```
mapping = {
    0:0, 1:0, 2:0, 3:0,          # Low-income group → 0
    4:1, 5:1, 6:1, 7:1, 8:1,     # mid-income group → 1
    9:2, 10:2, 11:2, 12:2        # high-income group → 2
}

data["H_INCOME_GROUPED"] = data["H_INCOME"].map(mapping).astype("int64")
```

In [9]:
```
# House Hold Income
data['Low_Income'] = (data['H_INCOME_GROUPED'] == 0).astype(int)
data['Middle_Income'] = (data['H_INCOME_GROUPED'] == 1).astype(int)
data['High_Income'] = (data['H_INCOME_GROUPED'] == 2).astype(int)
# Gender
data['Male'] = (data['SEX'] == 0).astype(int)
data['Female'] = (data['SEX'] == 1).astype(int)
# Age Group
data['Ag18_28'] = (data['AGE'] == 0).astype(int)
data['Ag29_39'] = (data['AGE'] == 1).astype(int)
data['Ag40_50'] = (data['AGE'] == 2).astype(int)
data['Ag51_60'] = (data['AGE'] == 3).astype(int)
data['Over_60'] = (data['AGE'] == 4).astype(int)
# Education
data['Below_08'] = (data['EDUC'] == 0).astype(int)
data['Eighth_Twelveth'] = (data['EDUC'] == 1).astype(int)
data['Diploma'] = (data['EDUC'] == 2).astype(int)
data['Degree'] = (data['EDUC'] == 3).astype(int)
data['Masters'] = (data['EDUC'] == 4).astype(int)
data['Above_Masters'] = (data['EDUC'] == 5).astype(int)
# Employment
data['Government'] = (data['EMPLOY'] == 0).astype(int)
data['Public'] = (data['EMPLOY'] == 1).astype(int)
data['Private'] = (data['EMPLOY'] == 2).astype(int)
data['Self'] = (data['EMPLOY'] == 3).astype(int)
# Marriage
data['Single'] = (data['MARR'] == 0).astype(int)
data['Married'] = (data['MARR'] == 1).astype(int)
data['Widowed'] = (data['MARR'] == 2).astype(int)
data['Divorced'] = (data['MARR'] == 3).astype(int)
# Number of Children
data['No_Ch'] = (data['CHILD'] == 0).astype(int)
data['One_Ch'] = (data['CHILD'] == 1).astype(int)
data['Two_Four_Ch'] = (data['CHILD'] == 2).astype(int)
data['AbvFour_Ch'] = (data['CHILD'] == 3).astype(int)
# Mode
data['LRT'] = (data['MODE'] == 0).astype(int)
data['City_Bus'] = (data['MODE'] == 1).astype(int)
data['Midi_Bus'] = (data['MODE'] == 2).astype(int)
data['Mini_Bus'] = (data['MODE'] == 3).astype(int)
data['Lada'] = (data['MODE'] == 4).astype(int)
data['Ride_Hailing'] = (data['MODE'] == 5).astype(int)
data['Private_Car'] = (data['MODE'] == 6).astype(int)
# Time of Departure
data['AM5_6AM'] = (data['DEP_TIME'] == 0).astype(int)
data['AM6_7AM'] = (data['DEP_TIME'] == 1).astype(int)
data['AM7_8AM'] = (data['DEP_TIME'] == 2).astype(int)
data['AM8_9AM'] = (data['DEP_TIME'] == 3).astype(int)
# Level of congestion
data['No_Cong'] = (data['LOC'] == 0).astype(int)
data['Rare_Cong'] = (data['LOC'] == 1).astype(int)
data['Som_Cong'] = (data['LOC'] == 2).astype(int)
data['Oft_Cong'] = (data['LOC'] == 3).astype(int)
data['Alw_Cong'] = (data['LOC'] == 4).astype(int)

# Save to CSV
data.to_csv("SP Data Modified.csv", index=False)
data
```

Out[9]:

| | ID | SP | P_INCOME | SEX | AGE | EDUC | EMPLOY | MARR | H_INCOME | CHILD | ... | Private_Car | AM5_6AM | AM6_7AM | AM7_8AM | AM8_9AM | No_Cong | Rare_Cong | Som_Cong | Oft_Cong |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **1** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **2** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **3** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **4** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2065** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2066** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2067** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2068** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2069** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

2070 rows × 69 columns

In [10]:

```python
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2070 entries, 0 to 2069
Data columns (total 69 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   ID                2070 non-null   int64
 1   SP                2070 non-null   int64
 2   P_INCOME          2070 non-null   int64
 3   SEX               2070 non-null   int64
 4   AGE               2070 non-null   int64
 5   EDUC              2070 non-null   int64
 6   EMPLOY            2070 non-null   int64
 7   MARR              2070 non-null   int64
 8   H_INCOME          2070 non-null   int64
 9   CHILD             2070 non-null   int64
 10  MODE              2070 non-null   int64
 11  CAR_TYPE          2070 non-null   int64
 12  DEP_TIME          2070 non-null   int64
 13  LOC               2070 non-null   int64
 14  FIRST_TT          2070 non-null   int64
 15  FIRST_TC          2070 non-null   int64
 16  FIRST_AV          2070 non-null   int64
 17  SECOND_TT         2070 non-null   int64
 18  SECOND_TC         2070 non-null   int64
 19  SECOND_AV         2070 non-null   int64
 20  DIFF              2070 non-null   int64
 21  AVER_DIST         2070 non-null   float64
 22  P_INCOME_GROUPED  2070 non-null   int64
 23  CHOICE            2070 non-null   int64
 24  H_INCOME_GROUPED  2070 non-null   int64
 25  Low_Income        2070 non-null   int32
 26  Middle_Income     2070 non-null   int32
 27  High_Income       2070 non-null   int32
 28  Male              2070 non-null   int32
 29  Female            2070 non-null   int32
 30  Ag18_28           2070 non-null   int32
 31  Ag29_39           2070 non-null   int32
 32  Ag40_50           2070 non-null   int32
 33  Ag51_60           2070 non-null   int32
 34  Over_60           2070 non-null   int32
 35  Below_08          2070 non-null   int32
 36  Eighth_Twelveth   2070 non-null   int32
 37  Diploma           2070 non-null   int32
 38  Degree            2070 non-null   int32
 39  Masters           2070 non-null   int32
 40  Above_Masters     2070 non-null   int32
 41  Government        2070 non-null   int32
 42  Public            2070 non-null   int32
 43  Private           2070 non-null   int32
 44  Self              2070 non-null   int32
 45  Single            2070 non-null   int32
 46  Married           2070 non-null   int32
 47  Widowed           2070 non-null   int32
 48  Divorced          2070 non-null   int32
 49  No_Ch             2070 non-null   int32
 50  One_Ch            2070 non-null   int32
 51  Two_Four_Ch       2070 non-null   int32
 52  AbvFour_Ch        2070 non-null   int32
 53  LRT               2070 non-null   int32
 54  City_Bus          2070 non-null   int32
 55  Midi_Bus          2070 non-null   int32
 56  Mini_Bus          2070 non-null   int32
 57  Lada              2070 non-null   int32
 58  Ride_Hailing      2070 non-null   int32
 59  Private_Car       2070 non-null   int32
 60  AM5_6AM           2070 non-null   int32
 61  AM6_7AM           2070 non-null   int32
 62  AM7_8AM           2070 non-null   int32
 63  AM8_9AM           2070 non-null   int32
 64  No_Cong           2070 non-null   int32
 65  Rare_Cong         2070 non-null   int32
 66  Som_Cong          2070 non-null   int32
 67  Oft_Cong          2070 non-null   int32
 68  Alw_Cong          2070 non-null   int32
dtypes: float64(1), int32(44), int64(24)
memory usage: 760.2 KB
```

## Define variables

In [12]:

```python
# Filter data for Stated Preference (SP) responses
#df = data[data['SP'] == 0] # Selecting PT Only
# df = data[data['SP'] == 1] # Selecting PrT Only
```

```
df = data # All together
df
```

Out[12]:

| | ID | SP | P_INCOME | SEX | AGE | EDUC | EMPLOY | MARR | H_INCOME | CHILD | ... | Private_Car | AM5_6AM | AM6_7AM | AM7_8AM | AM8_9AM | No_Cong | Rare_Cong | Som_Cong | Oft_Cong |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **1** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **2** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **3** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **4** | 1 | 0 | 1 | 0 | 0 | 3 | 2 | 0 | 3 | 0 | ... | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2065** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2066** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2067** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2068** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **2069** | 345 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | ... | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

2070 rows × 69 columns

## Define Biogeme database

In [14]:
```
database = db.Database('SP Data', df)
```

In [15]:
```
# for col in df.columns:
#     print(f"{col} = Variable('{col}')")
```

In [16]:
```
ID = Variable('ID')
SP = Variable('SP')
P_INCOME = Variable('P_INCOME')
SEX = Variable('SEX')
AGE = Variable('AGE')
EDUC = Variable('EDUC')
EMPLOY = Variable('EMPLOY')
MARR = Variable('MARR')
H_INCOME = Variable('H_INCOME')
CHILD = Variable('CHILD')
MODE = Variable('MODE')
CAR_TYPE = Variable('CAR_TYPE')
DEP_TIME = Variable('DEP_TIME')
LOC = Variable('LOC')
FIRST_TT = Variable('FIRST_TT')
FIRST_TC = Variable('FIRST_TC')
FIRST_AV = Variable('FIRST_AV')
SECOND_TT = Variable('SECOND_TT')
SECOND_TC = Variable('SECOND_TC')
SECOND_AV = Variable('SECOND_AV')
DIFF = Variable('DIFF')
AVER_DIST = Variable('AVER_DIST')
P_INCOME_GROUPED = Variable('P_INCOME_GROUPED')
CHOICE = Variable('CHOICE')
H_INCOME_GROUPED = Variable('H_INCOME_GROUPED')
Low_Income = Variable('Low_Income')
Middle_Income = Variable('Middle_Income')
High_Income = Variable('High_Income')
Male = Variable('Male')
Female = Variable('Female')
Age18_28 = Variable('Ag18_28')
Age29_39 = Variable('Ag29_39')
Age40_50 = Variable('Ag40_50')
Age51_60 = Variable('Ag51_60')
Over_60 = Variable('Over_60')
Below_08 = Variable('Below_08')
Eighth_Twelveth = Variable('Eighth_Twelveth')
Diploma = Variable('Diploma')
Degree = Variable('Degree')
Masters = Variable('Masters')
Above_Masters = Variable('Above_Masters')
Government = Variable('Government')
Public = Variable('Public')
Private = Variable('Private')
Self = Variable('Self')
Single = Variable('Single')
Married = Variable('Married')
Widowed = Variable('Widowed')
Divorced = Variable('Divorced')
No_Ch = Variable('No_Ch')
One_Ch = Variable('One_Ch')
Two_Four_Ch = Variable('Two_Four_Ch')
AbvFour_Ch = Variable('AbvFour_Ch')
LRT = Variable('LRT')
City_Bus = Variable('City_Bus')
Midi_Bus = Variable('Midi_Bus')
Mini_Bus = Variable('Mini_Bus')
Lada = Variable('Lada')
Ride_Hailing = Variable('Ride_Hailing')
Private_Car = Variable('Private_Car')
AM5_6AM = Variable('AM5_6AM')
AM6_7AM = Variable('AM6_7AM')
AM7_8AM = Variable('AM7_8AM')
AM8_9AM = Variable('AM8_9AM')
No_Cong = Variable('No_Cong')
Rare_Cong = Variable('Rare_Cong')
Som_Cong = Variable('Som_Cong')
Oft_Cong = Variable('Oft_Cong')
Alw_Cong = Variable('Alw_Cong')
```

In [17]:
```
FIRST_TT_SCALED = database.define_variable('FIRST_TT_SCALED', FIRST_TT / 10)
FIRST_TC_SCALED = database.define_variable('FIRST_TC_SCALED', FIRST_TC / 10)
SECOND_TT_SCALED = database.define_variable('SECOND_TT_SCALED', SECOND_TT / 1)
SECOND_TC_SCALED = database.define_variable('SECOND_TC_SCALED', SECOND_TC / 1)
```

## Paramaters to be estimated

```
[19]: # Defining Alternative Specific Constants
ASC_FIRST = Beta('ASC_FIRST', 0, None, None, 0)
ASC_SECOND = Beta('ASC_SECOND', 0, None, None, 1)
```

```
[20]: # Define Beta parameters
BETA_TIME = Beta('BETA_TIME', 0, None, None, 0)
BETA_COST = Beta('BETA_COST', 0, None, None, 0)
# House Hold Income
BETA_TIME_Low = Beta('BETA_TIME_Low', 0, None, None, 0)
BETA_COST_Low = Beta('BETA_COST_Low', 0, None, None, 0)
BETA_TIME_Middle = Beta('BETA_TIME_Middle', 0, None, None, 0)
BETA_COST_Middle = Beta('BETA_COST_Middle', 0, None, None, 0)
BETA_TIME_High = Beta('BETA_TIME_High', 0, None, None, 0)
BETA_COST_High = Beta('BETA_COST_High', 0, None, None, 0)
# Gender
BETA_TIME_Male = Beta('BETA_TIME_Male', 0, None, None, 0)
BETA_COST_Male = Beta('BETA_COST_Male', 0, None, None, 0)
BETA_TIME_Female = Beta('BETA_TIME_Female', 0, None, None, 0)
BETA_COST_Female = Beta('BETA_COST_Female', 0, None, None, 0)
# Age
BETA_TIME_18_28 = Beta('BETA_TIME_18_28', 0, None, None, 0)
BETA_COST_18_28 = Beta('BETA_COST_18_28', 0, None, None, 0)
BETA_TIME_29_39 = Beta('BETA_TIME_29_39', 0, None, None, 0)
BETA_COST_29_39 = Beta('BETA_COST_29_39', 0, None, None, 0)
BETA_TIME_40_50 = Beta('BETA_TIME_40_50', 0, None, None, 0)
BETA_COST_40_50 = Beta('BETA_COST_40_50', 0, None, None, 0)
BETA_TIME_51_60 = Beta('BETA_TIME_51_60', 0, None, None, 0)
BETA_COST_51_60 = Beta('BETA_COST_51_60', 0, None, None, 0)
BETA_TIME_Over_60 = Beta('BETA_TIME_Over_60', 0, None, None, 0)
BETA_COST_Over_60 = Beta('BETA_COST_Over_60', 0, None, None, 0)
# Education
BETA_TIME_Below_08 = Beta('BETA_TIME_Below_08', 0, None, None, 0)
BETA_COST_Below_08 = Beta('BETA_COST_Below_08', 0, None, None, 0)
BETA_TIME_Eighth_Twelveth = Beta('BETA_TIME_Eighth_Twelveth', 0, None, None, 0)
BETA_COST_Eighth_Twelveth = Beta('BETA_COST_Eighth_Twelveth', 0, None, None, 0)
BETA_TIME_Diploma = Beta('BETA_TIME_Diploma', 0, None, None, 0)
BETA_COST_Diploma = Beta('BETA_COST_Diploma', 0, None, None, 0)
BETA_TIME_Degree = Beta('BETA_TIME_Degree', 0, None, None, 0)
BETA_COST_Degree = Beta('BETA_COST_Degree', 0, None, None, 0)
BETA_TIME_Masters = Beta('BETA_TIME_Masters', 0, None, None, 0)
BETA_COST_Masters = Beta('BETA_COST_Masters', 0, None, None, 0)
BETA_TIME_Above_Masters = Beta('BETA_TIME_Above_Masters', 0, None, None, 0)
BETA_COST_Above_Masters = Beta('BETA_COST_Above_Masters', 0, None, None, 0)
# Employment
BETA_TIME_Government = Beta('BETA_TIME_Government', 0, None, None, 0)
BETA_COST_Government = Beta('BETA_COST_Government', 0, None, None, 0)
BETA_TIME_Public = Beta('BETA_TIME_Public', 0, None, None, 0)
BETA_COST_Public = Beta('BETA_COST_Public', 0, None, None, 0)
BETA_TIME_Private = Beta('BETA_TIME_Private', 0, None, None, 0)
BETA_COST_Private = Beta('BETA_COST_Private', 0, None, None, 0)
BETA_TIME_Self= Beta('BETA_TIME_Self', 0, None, None, 0)
BETA_COST_Self = Beta('BETA_COST_Self', 0, None, None, 0)
# Martial Status
BETA_TIME_Single = Beta('BETA_TIME_Single', 0, None, None, 0)
BETA_COST_Single = Beta('BETA_COST_Single', 0, None, None, 0)
BETA_TIME_Married = Beta('BETA_TIME_Married', 0, None, None, 0)
BETA_COST_Married = Beta('BETA_COST_Married', 0, None, None, 0)
BETA_TIME_Widowed = Beta('BETA_TIME_Widowed', 0, None, None, 0)
BETA_COST_Widowed = Beta('BETA_COST_Widowed', 0, None, None, 0)
BETA_TIME_Divorced = Beta('BETA_TIME_Divorced', 0, None, None, 0)
BETA_COST_Divorced = Beta('BETA_COST_Divorced', 0, None, None, 0)
# No of children
BETA_TIME_No_Ch = Beta('BETA_TIME_No_Ch', 0, None, None, 0)
BETA_COST_No_Ch = Beta('BETA_COST_No_Ch', 0, None, None, 0)
BETA_TIME_One_Ch = Beta('BETA_TIME_One_Ch', 0, None, None, 0)
BETA_COST_One_Ch = Beta('BETA_COST_One_Ch', 0, None, None, 0)
BETA_TIME_Two_Four_Ch = Beta('BETA_TIME_Two_Four_Ch', 0, None, None, 0)
BETA_COST_Two_Four_Ch = Beta('BETA_COST_Two_Four_Ch', 0, None, None, 0)
BETA_TIME_AbvFour_Ch = Beta('BETA_TIME_AbvFour_Ch', 0, None, None, 0)
BETA_COST_AbvFour_Ch = Beta('BETA_COST_AbvFour_Ch', 0, None, None, 0)
# Mode
BETA_TIME_LRT = Beta('BETA_TIME_LRT', 0, None, None, 0)
BETA_COST_LRT = Beta('BETA_COST_LRT', 0, None, None, 0)
BETA_TIME_City_Bus = Beta('BETA_TIME_City_Bus', 0, None, None, 0)
BETA_COST_City_Bus = Beta('BETA_COST_City_Bus', 0, None, None, 0)
BETA_TIME_Midi_Bus = Beta('BETA_TIME_Midi_Bus', 0, None, None, 0)
BETA_COST_Midi_Bus = Beta('BETA_COST_Midi_Bus', 0, None, None, 0)
BETA_TIME_Mini_Bus = Beta('BETA_TIME_Mini_Bus', 0, None, None, 0)
BETA_COST_Mini_Bus = Beta('BETA_COST_Mini_Bus', 0, None, None, 0)
BETA_TIME_Lada = Beta('BETA_TIME_Lada', 0, None, None, 0)
BETA_COST_Lada = Beta('BETA_COST_Lada', 0, None, None, 0)
BETA_TIME_Ride_Hailing = Beta('BETA_TIME_Ride_Hailing', 0, None, None, 0)
BETA_COST_Ride_Hailing = Beta('BETA_COST_Ride_Hailing', 0, None, None, 0)
BETA_TIME_Private_Car = Beta('BETA_TIME_Private_Car', 0, None, None, 0)
BETA_COST_Private_Car = Beta('BETA_COST_Private_Car', 0, None, None, 0)
# Time of Departure
BETA_TIME_AM5_6AM = Beta('BETA_TIME_AM5_6AM', 0, None, None, 0)
BETA_COST_AM5_6AM = Beta('BETA_COST_AM5_6AM', 0, None, None, 0)
BETA_TIME_AM6_7AM = Beta('BETA_TIME_AM6_7AM', 0, None, None, 0)
BETA_COST_AM6_7AM = Beta('BETA_COST_AM6_7AM', 0, None, None, 0)
BETA_TIME_AM7_8AM = Beta('BETA_TIME_AM7_8AM', 0, None, None, 0)
BETA_COST_AM7_8AM = Beta('BETA_COST_AM7_8AM', 0, None, None, 0)
BETA_TIME_AM8_9AM  = Beta('BETA_TIME_AM8_9AM', 0, None, None, 0)
BETA_COST_AM8_9AM  = Beta('BETA_COST_AM8_9AM', 0, None, None, 0)
# Level of Congestion
BETA_TIME_No_Cong = Beta('BETA_TIME_No_Cong', 0, None, None, 0)
BETA_COST_No_Cong = Beta('BETA_COST_No_Cong', 0, None, None, 0)
BETA_TIME_Rare_Cong = Beta('BETA_TIME_Rare_Cong', 0, None, None, 0)
BETA_COST_Rare_Cong = Beta('BETA_COST_Rare_Cong', 0, None, None, 0)
BETA_TIME_Som_Cong = Beta('BETA_TIME_Som_Cong', 0, None, None, 0)
BETA_COST_Som_Cong  = Beta('BETA_COST_Som_Cong', 0, None, None, 0)
BETA_TIME_Oft_Cong  = Beta('BETA_TIME_Oft_Cong', 0, None, None, 0)
BETA_COST_Oft_Cong = Beta('BETA_COST_Oft_Cong', 0, None, None, 0)
BETA_TIME_Alw_Cong  = Beta('BETA_TIME_Alw_Cong', 0, None, None, 0)
BETA_COST_Alw_Cong = Beta('BETA_COST_Alw_Cong', 0, None, None, 0)
# Distance
BETA_DISTANCE = Beta('BETA_DISTANCE', 0, None, None, 0)
```

## Utility function

```
In [22]: # #Without Scaling
V_FIRST = (ASC_FIRST +
    BETA_TIME * FIRST_TT +
    BETA_COST * FIRST_TC +
    # HouseHold Income
    BETA_TIME_Low            * Low_Income    * FIRST_TT +
    BETA_COST_Low            * Low_Income    * FIRST_TC +
    BETA_TIME_Middle         * Middle_Income * FIRST_TT +
    BETA_COST_Middle         * Middle_Income * FIRST_TC +
    # Gender
    BETA_TIME_Male           * Male          * FIRST_TT +
    BETA_COST_Male           * Male          * FIRST_TC +
    # Age groups
    BETA_TIME_Over_60        * Over_60       * FIRST_TT +
    BETA_COST_Over_60        * Over_60       * FIRST_TC +
    # Marital status
    BETA_TIME_Widowed        * Widowed       * FIRST_TT +
    BETA_COST_Widowed        * Widowed       * FIRST_TC +
    BETA_TIME_Divorced       * Divorced      * FIRST_TT +
    BETA_COST_Divorced       * Divorced      * FIRST_TC +
    # Current main mode
    BETA_TIME_LRT            * LRT           * FIRST_TT +
    BETA_COST_LRT            * LRT           * FIRST_TC +
    BETA_TIME_Midi_Bus       * Midi_Bus      * FIRST_TT +
    BETA_COST_Midi_Bus       * Midi_Bus      * FIRST_TC +
    BETA_TIME_City_Bus       * City_Bus      * FIRST_TT +
    BETA_COST_City_Bus       * City_Bus      * FIRST_TC +
    BETA_TIME_Mini_Bus       * Mini_Bus      * FIRST_TT +
    BETA_COST_Mini_Bus       * Mini_Bus      * FIRST_TC +
    BETA_TIME_Lada           * Lada          * FIRST_TT +
    BETA_COST_Lada           * Lada          * FIRST_TC +
    BETA_TIME_Ride_Hailing   * Ride_Hailing  * FIRST_TT +
    BETA_COST_Ride_Hailing   * Ride_Hailing  * FIRST_TC +
    BETA_TIME_Private_Car    * Private_Car   * FIRST_TT +
    BETA_COST_Private_Car    * Private_Car   * FIRST_TC
    )


V_SECOND = (ASC_SECOND +
    BETA_TIME * SECOND_TT +
    BETA_COST * SECOND_TC +
    # Household Income
    BETA_TIME_Low            * Low_Income    * SECOND_TT +
    BETA_COST_Low            * Low_Income    * SECOND_TC +
    BETA_TIME_Middle         * Middle_Income * SECOND_TT +
    BETA_COST_Middle         * Middle_Income * SECOND_TC +
    # Gender
    BETA_TIME_Male           * Male          * SECOND_TT +
    BETA_COST_Male           * Male          * SECOND_TC +
    # Age groups
    BETA_TIME_Over_60        * Over_60       * SECOND_TT +
    BETA_COST_Over_60        * Over_60       * SECOND_TC +
    # Marital status
    BETA_TIME_Widowed        * Widowed       * SECOND_TT +
    BETA_COST_Widowed        * Widowed       * SECOND_TC +
    BETA_TIME_Divorced       * Divorced      * SECOND_TT +
    BETA_COST_Divorced       * Divorced      * SECOND_TC +
    # Current main mode
    BETA_TIME_LRT            * LRT           * SECOND_TT +
    BETA_COST_LRT            * LRT           * SECOND_TC +
    BETA_TIME_Midi_Bus       * Midi_Bus      * SECOND_TT +
    BETA_COST_Midi_Bus       * Midi_Bus      * SECOND_TC +
    BETA_TIME_City_Bus       * City_Bus      * SECOND_TT +
    BETA_COST_City_Bus       * City_Bus      * SECOND_TC +
    BETA_TIME_Mini_Bus       * Mini_Bus      * SECOND_TT +
    BETA_COST_Mini_Bus       * Mini_Bus      * SECOND_TC +
    BETA_TIME_Ride_Hailing   * Ride_Hailing  * SECOND_TT +
    BETA_COST_Ride_Hailing   * Ride_Hailing  * SECOND_TC +
    BETA_TIME_Private_Car    * Private_Car   * SECOND_TT +
    BETA_COST_Private_Car    * Private_Car   * SECOND_TC
    )
```

```
In [23]: V = {1: V_FIRST , 2: V_SECOND}
```

```
In [24]: av = {1: FIRST_AV , 2:SECOND_AV}
```

## Logit model-with out scaling

```
In [26]: logprob = models.loglogit(V, av, CHOICE)
```

```
In [27]: the_biogeme = bio.BIOGEME(database, logprob)
the_biogeme.modelName = 'Main Base Model-1' # Combined Model
```

```
File biogeme.toml has been created
```

```
In [28]: results = the_biogeme.estimate()
```

```
In [29]: print(results.short_summary())
```

```
Results for model Main Base Model-1
Nbr of parameters:              29
Sample size:                    2070
Excluded data:                  0
Final log likelihood:           -1125.828
Akaike Information Criterion:   2309.657
Bayesian Information Criterion: 2473.081
```

```
In [30]: display(results.get_estimated_parameters())
```

| | Value | Rob. Std err | Rob. t-test | Rob. p-value |
|---|---|---|---|---|
| ASC_FIRST | 0.111549 | 0.052877 | 2.109602 | 3.489266e-02 |
| BETA_COST | -0.074980 | 0.004670 | -16.055988 | 0.000000e+00 |
| BETA_COST_City_Bus | 0.067956 | 0.007114 | 9.552148 | 0.000000e+00 |
| BETA_COST_Divorced | 0.122814 | 0.018949 | 6.481252 | 9.096479e-11 |
| BETA_COST_LRT | 0.154559 | 0.019241 | 8.032660 | 8.881784e-16 |
| BETA_COST_Lada | 0.020271 | 0.003012 | 6.730809 | 1.687228e-11 |
| BETA_COST_Low | 0.000638 | 0.001648 | 0.387192 | 6.986142e-01 |
| BETA_COST_Male | -0.000267 | 0.001471 | -0.181745 | 8.557827e-01 |
| BETA_COST_Middle | -0.001422 | 0.001533 | -0.928002 | 3.534063e-01 |
| BETA_COST_Midi_Bus | 0.060008 | 0.009340 | 6.424612 | 1.322062e-10 |
| BETA_COST_Mini_Bus | 0.055340 | 0.005301 | 10.439402 | 0.000000e+00 |
| BETA_COST_Over_60 | -0.006827 | 0.066986 | -0.101915 | 9.188241e-01 |
| BETA_COST_Private_Car | 0.067919 | 0.004854 | 13.991924 | 0.000000e+00 |
| BETA_COST_Ride_Hailing | 0.070222 | 0.005002 | 14.039837 | 0.000000e+00 |
| BETA_COST_Widowed | 0.161622 | 0.021518 | 7.511051 | 5.861978e-14 |
| BETA_TIME | -0.062141 | 0.030933 | -2.008896 | 4.454811e-02 |
| BETA_TIME_City_Bus | 0.012028 | 0.031785 | 0.378402 | 7.051321e-01 |
| BETA_TIME_Divorced | -0.064666 | 0.016317 | -3.962992 | 7.401621e-05 |
| BETA_TIME_LRT | -0.087553 | 0.037134 | -2.357744 | 1.838636e-02 |
| BETA_TIME_Lada | -0.030658 | 0.018425 | -1.663985 | 9.611534e-02 |
| BETA_TIME_Low | 0.011618 | 0.004973 | 2.336371 | 1.947193e-02 |
| BETA_TIME_Male | 0.009725 | 0.004010 | 2.425108 | 1.530382e-02 |
| BETA_TIME_Middle | 0.015932 | 0.004787 | 3.327964 | 8.748312e-04 |
| BETA_TIME_Midi_Bus | 0.018376 | 0.032266 | 0.569515 | 5.690068e-01 |
| BETA_TIME_Mini_Bus | 0.005041 | 0.031117 | 0.161986 | 8.713166e-01 |
| BETA_TIME_Over_60 | 0.272859 | 0.084009 | 3.247964 | 1.162339e-03 |
| BETA_TIME_Private_Car | 0.018121 | 0.031397 | 0.577155 | 5.638350e-01 |
| BETA_TIME_Ride_Hailing | 0.022094 | 0.032095 | 0.688395 | 4.912042e-01 |
| BETA_TIME_Widowed | -0.027360 | 0.019444 | -1.407075 | 1.594051e-01 |

In [31]:
```
print(results.print_general_statistics())
```

```
Number of estimated parameters: 29
Sample size:    2070
Excluded observations:  0
Init log likelihood:    -1434.815
Final log likelihood:   -1125.828
Likelihood ratio test for the init. model:      617.9725
Rho-square for the init. model: 0.215
Rho-square-bar for the init. model:     0.195
Akaike Information Criterion:   2309.657
Bayesian Information Criterion: 2473.081
Final gradient norm:    2.1630E-01
Nbr of threads: 12
```

In [32]:
```
# Calculate VOT for PT
VOT_Minute = (results.get_beta_values()['BETA_TIME'] / results.get_beta_values()['BETA_COST']).round(3)
print(f'VOT (Birr/min): {VOT_Minute}')

# Calculate VOT for PrT
VOT_Hour = (VOT_Minute*60).round(3)
print(f'VOT (Birr/hr): {VOT_Hour}')
```

```
VOT (Birr/min): 0.829
VOT (Birr/hr): 49.74
```

## Logit model-with scaling

In [34]:
```
V_FIRST = (ASC_FIRST +
    BETA_TIME * FIRST_TT_SCALED +
    BETA_COST * FIRST_TC_SCALED +
    # Household Income
    BETA_TIME_Low           * Low_Income    * FIRST_TT_SCALED +
    BETA_COST_Low           * Low_Income    * FIRST_TC_SCALED +
    BETA_TIME_Middle        * Middle_Income * FIRST_TT_SCALED +
    BETA_COST_Middle        * Middle_Income * FIRST_TC_SCALED +
    #Gender
    BETA_TIME_Male          * Male          * FIRST_TT_SCALED +
    BETA_COST_Male          * Male          * FIRST_TC_SCALED +
    # Age groups
    BETA_TIME_Over_60       * Over_60       * FIRST_TT_SCALED +
    BETA_COST_Over_60       * Over_60       * FIRST_TC_SCALED +
    # Marital status
    BETA_TIME_Widowed       * Widowed       * FIRST_TT_SCALED +
    BETA_COST_Widowed       * Widowed       * FIRST_TC_SCALED +
    BETA_TIME_Divorced      * Divorced      * FIRST_TT_SCALED +
    BETA_COST_Divorced      * Divorced      * FIRST_TC_SCALED +
    # Current main mode
    BETA_TIME_LRT           * LRT           * FIRST_TT_SCALED +
    BETA_COST_LRT           * LRT           * FIRST_TC_SCALED +
    BETA_TIME_City_Bus      * City_Bus      * FIRST_TT_SCALED +
    BETA_COST_City_Bus      * City_Bus      * FIRST_TC_SCALED +
    BETA_TIME_Midi_Bus      * Midi_Bus      * FIRST_TT_SCALED +
    BETA_COST_Midi_Bus      * Midi_Bus      * FIRST_TC_SCALED +
    BETA_TIME_Mini_Bus      * Mini_Bus      * FIRST_TT_SCALED +
    BETA_COST_Mini_Bus      * Mini_Bus      * FIRST_TC_SCALED +
```

| | Value | Rob. Std err | Rob. t-test | Rob. p-value |
|---|---|---|---|---|
| **ASC_FIRST** | -3.122401 | 0.417864 | -7.472295 | 7.882583e-14 |
| **BETA_COST** | -0.007401 | 0.001301 | -5.688316 | 1.282984e-08 |
| **BETA_COST_City_Bus** | -0.003757 | 0.004658 | -0.806512 | 4.199475e-01 |
| **BETA_COST_Divorced** | 0.154013 | 0.010514 | 14.648557 | 0.000000e+00 |
| **BETA_COST_LRT** | 0.158069 | 0.011013 | 14.352767 | 0.000000e+00 |
| **BETA_COST_Lada** | -0.086157 | 0.007277 | -11.840167 | 0.000000e+00 |
| **BETA_COST_Low** | 0.000349 | 0.001251 | 0.278574 | 7.805719e-01 |
| **BETA_COST_Male** | -0.000356 | 0.001031 | -0.345614 | 7.296329e-01 |
| **BETA_COST_Middle** | -0.002294 | 0.001026 | -2.235541 | 2.538182e-02 |
| **BETA_COST_Midi_Bus** | -0.014412 | 0.006445 | -2.236098 | 2.534538e-02 |
| **BETA_COST_Mini_Bus** | -0.008562 | 0.003385 | -2.529170 | 1.143327e-02 |
| **BETA_COST_Over_60** | -0.173501 | 0.024804 | -6.994942 | 2.653655e-12 |
| **BETA_COST_Ride_Hailing** | 0.000622 | 0.001110 | 0.560166 | 5.753665e-01 |
| **BETA_COST_Widowed** | 0.163410 | 0.011815 | 13.831115 | 0.000000e+00 |
| **BETA_TIME** | -0.027996 | 0.004716 | -5.936836 | 2.905751e-09 |
| **BETA_TIME_City_Bus** | -0.016652 | 0.003050 | -5.459702 | 4.769339e-08 |
| **BETA_TIME_Divorced** | -0.107028 | 0.006876 | -15.564944 | 0.000000e+00 |
| **BETA_TIME_LRT** | -0.129635 | 0.007446 | -17.409863 | 0.000000e+00 |
| **BETA_TIME_Lada** | 0.268532 | 0.014836 | 18.099942 | 0.000000e+00 |
| **BETA_TIME_Low** | 0.004252 | 0.001668 | 2.548593 | 1.081585e-02 |
| **BETA_TIME_Male** | 0.004317 | 0.001379 | 3.131836 | 1.737170e-03 |
| **BETA_TIME_Middle** | 0.005921 | 0.001628 | 3.636413 | 2.764613e-04 |
| **BETA_TIME_Midi_Bus** | -0.009699 | 0.003725 | -2.603552 | 9.226334e-03 |
| **BETA_TIME_Mini_Bus** | -0.012539 | 0.002435 | -5.148583 | 2.624617e-07 |
| **BETA_TIME_Over_60** | 0.122927 | 0.014523 | 8.464299 | 0.000000e+00 |
| **BETA_TIME_Ride_Hailing** | -0.007535 | 0.003862 | -1.951073 | 5.104836e-02 |
| **BETA_TIME_Widowed** | -0.103169 | 0.007402 | -13.938873 | 0.000000e+00 |

In [42]:
```
print(results.print_general_statistics())
```

```
Number of estimated parameters: 27
Sample size:    2070
Excluded observations:  0
Init log likelihood:    -5297.486
Final log likelihood:   -1221.409
Likelihood ratio test for the init. model:      8152.153
Rho-square for the init. model: 0.769
Rho-square-bar for the init. model:     0.764
Akaike Information Criterion:   2496.819
Bayesian Information Criterion: 2648.972
Final gradient norm:    9.1625E-02
Nbr of threads: 12
```

In [43]:
```
# Calculate VOT for PT
VOT_Minute = (results.get_beta_values()['BETA_TIME'] / results.get_beta_values()['BETA_COST']).round(3)
print(f'VOT (Birr/min): {VOT_Minute}')

# Calculate VOT for PrT
VOT_Hour = (VOT_Minute*60).round(3)
print(f'VOT (Birr/hr): {VOT_Hour}')
```

```
VOT (Birr/min): 3.783
VOT (Birr/hr): 226.98
```