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Estimation of Value of Travel Time Saving for Commuter Trips: A case study of Kathmandu

by

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A THESIS

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled **"Estimation of Value of Travel Time Saving for Commuter Trips: A case study of Kathmandu"** submitted by **Ashim Gautam** in partial fulfilment of the requirements for the degree of Master of Science in Transportation Engineering.

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ABSTRACT

Value of travel time (VTT) comprises a significant portion of benefits of transport infrastructure investment, in cost-benefit analysis, affecting viability of transportation projects. This study focuses on determining value attached to travel time saving and reliability associated with commuters in Kathmandu valley. Perception survey was conducted before collection of data by Revealed Preference/ Stated Preference (RP/SP) method. VTT from RP data, adopting multinomial logit model, resulted in Rs. 114.65 per hour. Uncorrelated mixed logit model was adopted for SP data. VTT from SP survey resulted in Rs. 67.48 per hour and Rs. 112.39 per hour for public vehicle user and private two-wheeler user respectively. VTT for work trips was estimated as Rs. 129.42 per hour and Rs. 129.64 per hour for public vehicle user and private two-wheeler user respectively depicting higher value for work trips. VTT estimated from RP and SP survey are comparable.

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LIST OF ABBREVIATIONS

ADB – Asian Development Bank

DoR – Department of Roads

RP – Revealed Preference

SP – Stated Preference

TPPF – Transport Project Preparatory Facility

VOC – Vehicle Operating Cost

VoT – Value of Time

VTT – Value of Travel Time

VTTS – Value of Travel Time Saving

CHAPTER 1 INTRODUCTION

1.1 Background

Transportation and economic progress of a region are closely related. Socio-economic improvements as an outcome of transportation investment are higher in under-developed and developing countries compared to countries on the other end of spectrum. The concept of transportation investment as a prerequisite to economic progress is often debated. International (and historical) experiences shows that inadequate transportation system act as bottleneck to overall development (Eddington, 2006). Travel time saving and associated monetized benefit comprises a portion of benefit as a result of transportation investment.

The value of travel time is a crucial factor in evaluating the benefits of transportation infrastructures investment and rulemaking incentives (Departmental Guidance for Conducting Economic Evaluations Revision 2). For example, in the UK, travel time savings have accounted for around 80% of the monetized benefits within cost-benefit analysis of major road scheme (Mackie, et al., 2001). Without reliable methods to value travel time savings, economists continue to use vehicle operating costs as means to assess investments (exceptions are urban, inter-urban and multilateral or bilateral donor assisted rural transport projects) (Transport for Rural Development, 2002). The experience is similar in Nepal. In order to undertake a cost benefit analysis of road investment and road maintenance information on vehicle operating cost (VOC) are required (MRCU-MAINTENANCE REHABILITATION CO-ORDINATION, 2001).

Value of travel time (VoT / VTT) can be defined as the monetary value attached to particular travel time and the value attached to possibility to save particular amount of travel time is value of travel time saving (VTTS). Value of travel time is implicit trade-off between time and money in travel demand model. It depends on trip purpose (business, personal), personal characteristics (age, sex, education and employment), income, mode and distance (within city, intercity), comfort. Two individuals with similar trip and socio-economic characteristics may have different VTT. VTTS is formulated as utility maximization problem (profit maximization in case of freight), based on microeconomic theory, employing behavioral models of discrete choice theory (Button & Peter, 2012)

Discrete choice problems involve the selection of alternatives from finite set of mutually exclusive and exhaustive discrete choice options (Button & Peter, 2012). Discrete choice models are based on choices made by individuals when presented with aforementioned choices. Two individuals presented with same choice may respond differently. Multinomial Logit Model, Mixed Logit Model, Nested Logit Models and Multinomial Probit Model are some of the popular discrete choice models.

Revealed preference (RP) is the choices made by decision maker in actual situation like mode of travel used. The used mode is dependent on other socio-economic and trip characteristics like income, proximity to destination, length of trip, etc. Stated-preference (SP) is choices made when presented with plenty of hypothetical choices (like altered travel time, cost, comfort, reliability, etc.) not limited by real life constraint (Dios Ort´uzar & Willumsen, 2011). Instead of relying on either RP or SP, combination of both is often employed for discrete choice modelling.

1.2 Problem statement

Value of Travel Time (VTT) comprises a portion of monetized benefit of transportation investment. VTT, when used in project appraisal in Nepal, is based on wage rate. The researches linking wage rate and VTT are lacking in Nepal and use of such relationship based on international experience might not be the best representation of VTT in our context. Rather, use of RP/SP approach to estimate VTT is more relevant.

Kathmandu is capital of Nepal and economic hub as well. With ever increasing population, trips are bound to increase. Trips comprises time of individuals which needs to be valued. With increasing trips, congestion is likely to increase, and investments in new schemes might be imminent. Trips made could generally be seen as commute and non-commute trips. Commute trips, in general, represent frequent trips between an individual's place of residence to place of work, or study. Trips to work, trips to school, business trips and trips to home constitute about 90% of total trips made in 2011 (JICA, 2012). In general, such trips are made on daily basis and agree with general definition of commuter trips. Since, commuter trips make a large portion of total trips, a study is necessary to estimate value of travel time of commuter trips in Kathmandu based on RP/SP approach.

1.3 Research Questions

- What is Value of Travel Time Saving of commuters in Kathmandu valley?
- What is Value of Travel Time Reliability of commuters in Kathmandu valley?

1.4 Research Objectives

The general objective of this study is to assess if value can be attached to travel time of commuters in Kathmandu valley.

The specific objectives of the study are:

- To determine Value of Travel Time Saving of commuters in Kathmandu valley.
- To determine Value of Travel Time Reliability of commuters in Kathmandu valley.

1.5 Limitations

- Safety and comfort were not incorporated into alternatives, though people were willing to pay as per perception survey, as they are difficult to quantify.
- Only two-wheeler users were included in analysis of SP data of private vehicle users.

1.6 Organization of Report

This report is organized in six chapters as described below:

Chapter 1 **Introduction** discusses about Value of Travel Time and foregrounds the need for the study.

Chapter 2 **Literature review** consists of discussion on accessible literature on value of time, discrete choice theory, choice data, value of travel time, value of travel time reliability, and sampling and provides basis for the study.

Chapter 3 **Methodology** elucidates perception survey, experimental design for RP/SP survey, sampling and data collection followed to carry out the study.

Chapter 4 **Analysis of data from Perception Survey** presents observation which are the basis of experimental design of RP/SP survey.

Chapter 5 **Analysis of RP/SP Data** explains the analysis framework and presents the estimated value of travel time and value of travel time reliability.

Chapter 6 **Conclusion and Recommendation** concludes the findings and considerations for new research.

CHAPTER 2 LITERATURE REVIEW

2.1 Value of Time

Several research works have been done regarding the theory and practice of valuing time. “A Theory of the Allocation of Time”, seminal work by Becker (1965) led foundations to further research work relating to valuation of time. Value of time emerged as opportunity cost of assigning time to any activity but work and that was wage rate. Household try to maximize their utility under the constraints of time and monetary budget. Becker estimated marginal value of time of commuters at about two-fifth of average hourly earnings.

DeSerpa (1971) added technological constraint in addition to time and monetary budget as time and cost are not continuously substitutable but limited to the technological possibilities defined by existing travel modes. DeSerpa defined μ and λ Lagrangian multiplier for time and monetary budget constraints and introduced K_i as Lagrangian multiplier for technological constraint. The ratio $(\mu-K_i)/\lambda$ is denoted as value of time and K_i/λ as value of saving time.

Truong and Hensher (1985) adopted discrete-choice models to measure travel time values and opportunity cost using both Becker and DeSerpa theory. They interpreted μ and λ Lagrangian multiplier for time and monetary budget constraints for Becker’s work and referred μ/λ as shadow price of time. Bates (1987) highlighted the shortcomings of Troung’s work caused due to a small number of crucial misunderstandings on interpretation of Lagrangian multipliers.

2.2 Discrete Choice Theory

Discrete choice analysis is the study of behavior of individual decision-makers in situations where they face discrete choice problems. The problems involve selection of alternatives from finite set of mutually exclusive and discrete choice options (Button & Peter, 2012). An individual chooses an alternative among the set of alternatives if the utility of that alternative is maximum for him/her. Concepts applied in consumer theory can be extended but with a discrete representation of alternatives (Ben-Akiva & Lerman, 1985). Many a researcher, under different assumptions about characteristics of choice probability, showed that different discrete choice model being consistent with utility maximization (Train, 2009).

2.3 Choice Data

Choices are central to discrete choice modelling. Attributes related to alternatives and characteristics, represented by socio-economic variables, related to individual's prejudice influence choice behavior. Model estimation aims at attaching relative weights for these attributes and characteristics. Socio-demographic (socio-economic) data represent data related to characteristics. Stated preference (SP) and revealed preference (RP) data are data associated with the attributes. (Hensher, et al., 2005)

2.3.1 Revealed preference data

Revealed preference (RP) data represents data collected in real life choices i.e. the choices the decision-makers have actually made. Since, RP data is collected on choices made in actual scenario adding to real world representation and reliability and validity but analysis is limited to current alternatives only (Hensher, et al., 2005).

2.3.2 Stated preference data

Stated preference (SP) data represents data collected on choices stated or made by decision-makers in hypothetical scenario. Hypothetical scenario, not limited by real life choice constraints, may lead to situations where respondents may not consider constraints at the time of choice. Therefore, analyst should make the alternatives as realistic as possible (Hensher, et al., 2005).

Figure 2. 1, reproduction of figure 4.1 from (Hensher, et al., 2005), illustrates the discussion that RP data represent information up to the extent of current technological frontier whilst SP data allows to attributes, alternatives and attribute levels outside technological frontier.

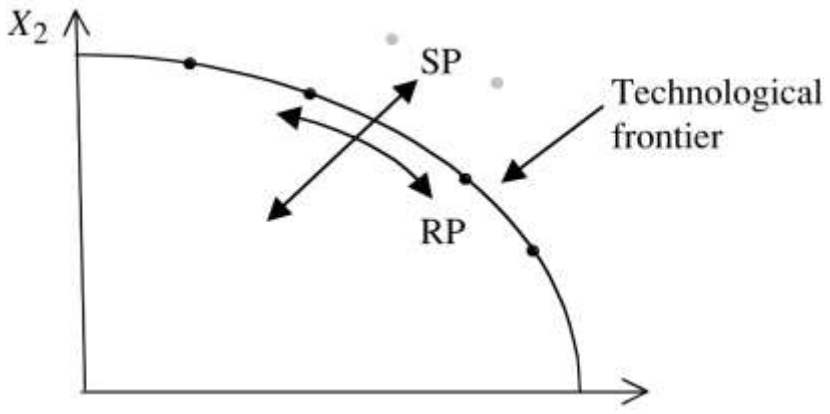

Figure 2. 1: Technological Frontier and RP and SP data *(Hensher, et al., 2005)*

Whether responses in SP are representations of actual choices is longstanding concern. Strategic bias may occur where respondents quote higher or lower VTT to influence policy decisions (Abrantes & Wardman, 2011).

2.4 Value of Travel Time

Shires and Jong (2009) computed income elasticity of VTTS using cross-sectional data to be 0.5 for business travel, 0.7 for commuter and 0.5 for other passenger transport. Abrantes and Wardman (2011) presented an GDP elasticity of 0.9 with narrow confidence interval estimated over 45 years contrasting with cross-sectional evidence.

Fezzi, et al. (2014) adopted revealed preference survey, conditional logit model for analysis, to estimate value of travel time for recreational purposes, in Italy, to be about ¾ of average wage rate. The monetary value was €8.4/h to €9.4/h. They concluded VTT to increase with income and decrease for those who are older than 60 years old. Departmental Guidance for Conducting Economic Evaluations Revision 2 recommends 50% and 70% of median hourly earnings as VTTS for personal travel local and intercity respectively. Similarly, 100% is recommended value for business travel. Athira, et al. (2016) estimated VTT for work trips adopting RP-SP approach and concluded that income and travel distance had substantial influence (positive influence) in VTT. Athira, et al. calculated the VTT within range of 31% to 121% of hourly income using binary logit model.

Hensher (2006) found that VTT obtained from Multinomial Logit Model were underestimation compared to that of Mixed Logit model, but the degree of underestimation is quite variable. Mixed Logit model disentangles Independence of Irrelevant Alternatives (IIA) from Independently and Identically Distributed (IID) and enables the analyst to estimate models that account for cross-correlation among the alternatives (Hensher, 2001). The use of mixed logit model to evaluate VTTS has accelerated (Hensher, 2006) and (Hensher, 2001) adopted mixed logit model in analysis.

Transport for Rural Development (2002) adopted RP-SP method to value travel time saving in Bangladesh as 3.5 Tk/hour and 3.95 Tk/hour for in-vehicle time and walking time respectively along with value attached to comfort. They used hierarchical logit model (Nested Logit model) for analysis of RP data. Athira, et al. (2016) computed

Value of Travel Time Saving to be Indian Rupees 35.73 per hour to Indian Rupees 142.19 per hour for different work trips in Calicut city India.

Ghimire and Marsani (2019) adopted RP method for mode choice modeling of work trips in Kathmandu valley. The tradeoff between time coefficient and cost coefficient in utility equation formulated, choosing public transport as reference category, results in Nepali Rupees 46.27 per hour for two-wheeler and Nepali Rupees 55.8 per hour for four-wheeler traveler. Joshi and Acharya (2019) conducted mode choice modelling for intercity travel in Nepal, adopting RP-SP approach, and recommended Nepali Rupees 95 per hour as value of travel time. Ghimire and Marsani (2019) and Joshi and Acharya (2019) adopted multinomial logit model.

Bajracharya (2017) adopted revealed preference survey to estimate value of travel time for work trips in Kathmandu valley. Bajracharya estimated value of travel time, in Nepali Rupees per hour, as Rupees 25.11 to Rupees 180 for different categories of variables adopting binary logit model.

MRCU-MAINTENANCE REHABILITATION CO-ORDINATION (2001), while estimating road user cost, used one-third of wage rate as value of time as a part of vehicle operating cost. One third wage rate resulted in Nepali Rupees 5.3 per hour. MRCU recommended to carry out research to check passenger value of time adopting methods like stated preference. ADB on "Guidelines for the Economic Analysis of Projects" recommends hourly wage for value of work time saved while a proportion of hourly wage for leisure time (Bank, 2017).

Highway development and management (HDM) models is used to carry out economic, and engineering, analysis. Passenger working time and passenger non-working time is one of the key inputs to the model to estimate passenger delay cost, in vehicle fleet data, in model. Similarly, in the model, time saving cost constitutes road user cost.

Neupane (2015) adopted passenger working time as Nepali Rupees 12 per hour in vehicle fleet data for use in HDM-4. Asian Development Bank ADB (2017), in the report "Rural Connectivity Improvement Project: Report and Recommendation of the President" adopted value of passenger work time, in Nepali Rupees per hour, as Rs. 108, Rs. 180 and Rs. 83 for motorcycle, car/four-wheel drive and bus respectively . And adopted value of passenger non-work time, in Nepali Rupees per hour, as Rs. 27, Rs.

45 and Rs. 21 for motorcycle, car/four-wheel drive and bus respectively. Shrestha (2019) adopted working time value, in Nepali Rupees per hour, of Rs. 62, Rs. 72, Rs. 72, Rs. 95, Rs. 95, Rs. 72 and Rs. 62 for passenger of bus, minibus, micro bus, car/van taxi, four-wheel drive, motorcycle and three-wheeler respectively. Similarly, Nepali Rs. 19, Rs. 21, Rs. 21, Rs. 29, Rs. 29, Rs. 21 and Rs. 19 per hour as non-working time value for passenger of bus, minibus, micro bus, car/van taxi, four-wheel drive, motorcycle and three-wheeler respectively. The values were based on DoR, TPPF (2014).

Nepal (2012) adopted travel time cost, in $ per passenger-hour, as 0.37, 0.74, 0.29 0.29, 0.25 and 0.25 for motorcycle, car medium, goods vehicle, bus medium, truck light and truck medium users respectively as input to Roads Economics Decision Model (RED).

Appendix D presents the Value of Travel Time from different literatures converting in US$. The exchange rates used are adopted from provided values in the literature, if available. If exchange rates are not available in corresponding literature, yearly average of the year when research was done is adopted.

2.5 Value of Reliability

Reliability, closely associated with reliability, has been viewed as source of utility distinct from reduction of expected travel time. Travelers include buffer in their schedule, if uncertain about travel time, sacrificing time in origin to insure against costly delay in arriving destination (Departmental Guidance for Conducting Economic Evaluations Revision 2). It is estimated that for motorway widening scheme the total value of reliability benefits is the in order of an additional 50% above value of travel time saving (Eddington, 2006).

2.6 Sampling

Samples are the subsets of population. The sample should be representative of population such that correct inferences are drawn about the population. Sampling strategies include, but are not limited to, simple random samples, stratified random samples and choice-based samples.

In simple random sample, individuals are chosen randomly and purely by chance. Large sample sizes may be needed to ensure sufficient data on minority option of particular interest (Dios Ort´uzar & Willumsen, 2011)

In stratified random sampling, population is subdivided into mutually exclusive groups each representing a proportion of total population. Then, random sampling is adopted in each stratum (Hensher, et al., 2005)

In situations where an alternative is rarely chosen, choice-based sampling (CBS) is adopted. In this method, population is stratified based on choices considered (Dios Ort´uzar & Willumsen, 2011). This method may lead to disproportionately over sampling and under sampling relative to market share for less popular and more popular alternative respectively. Choice-based sampling is adopted for revealed preference (RP) data and not on SP data (Hensher, et al., 2005)

CHAPTER 3 METHODOLOGY

An overview of methodology, adopted for study, is presented in *Figure 3. 1* which is further elaborated in subsequent sections.

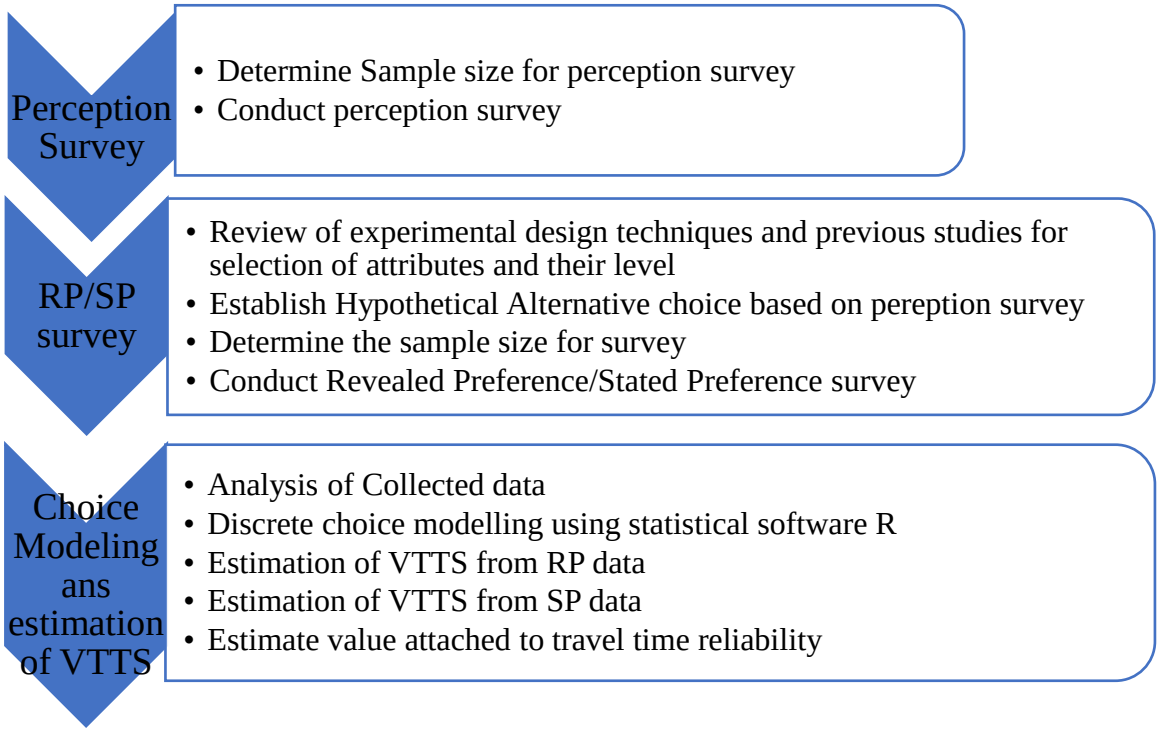

Figure 3. 1: Overview of Methodology

3.1 Perception Survey

3.1.1 Study Area and Sample Size

Study population comprises commuters in Kathmandu valley. Perception survey was carried out to assess if people are willing to pay extra to reduce in-vehicle travel time. Other parameters including willingness to pay for safety, comfort, reliability, etc. too were assessed in perception survey.

Random sampling was adopted for perception survey.

Sample size is determined using following formula (Dios Ort´uzar & Willumsen, 2011)

$$n = \frac{\bar{n}}{1+\frac{\bar{n}}{N}}$$

Where,

N is total population

n is sample size from finite population

$\bar{n}$ is sample size from infinite population

Sample size for infinite population is calculated using:

$$\bar{n} = \frac{S^2}{se(\bar{x})^2}$$

Where,

S^2 = variance of population

$se(\bar{x})^1$ is standard error of sampling population

For 95% confidence level, sample size is calculated as:

$$se(\bar{x})^2 = \frac{0.1\mu}{1.96} = 0.051\mu$$

$$\bar{n} = \frac{S^2}{(0.051\mu)^2} = 384cv^2$$

Taking coefficient of variation as 1 and $\frac{\bar{n}}{N}$ being very small, minimum sample size is taken as 384 which was collected for perception survey. A total of 430 observations from Kathmandu valley commuters was collected in perception survey. Discarding the incomplete data resulted in 384 observations which was used for analysis.

3.1.2 Data Collection

Google forms and printed forms were distributed to collect information on

- Number of trips in a day
- Purpose of trip
- Average distance
- Average, Minimum and Maximum in-vehicle travel time
- Mode of transport
- Perceived cost by private vehicle user
- Travel cost for public vehicle user
- Willingness to pay for travel time saving
- Willingness to pay for other factors than travel time

The trip purpose obtained from perception survey was further classified as:

- Business trip: Business and Business-related works
- Work trip: Work, Employment, Economic activity, Job, Office, In-work travel
- Study trip: College, School, Tuition, etc.
- Work and study
- Others: Recreation, Social activity and others

The analysis of data from perception survey is presented in Chapter 4.

3.2 RP/SP Survey

RP survey deals with attributes of the choices already made by the decision makers. The decision makers might be choice takers rather than choice makers in real life and might not be true preference. Thus, this study focuses on SP design to explore the alternate choice scenarios for decision makers to capture their VTT. SP survey, being based on hypothetical alternatives and choices, requires experimental design. *Figure 3. 2*, adaptation of figure 5.1 from (Hensher, et al., 2005), summarizes the experimental design process adopted in this study.

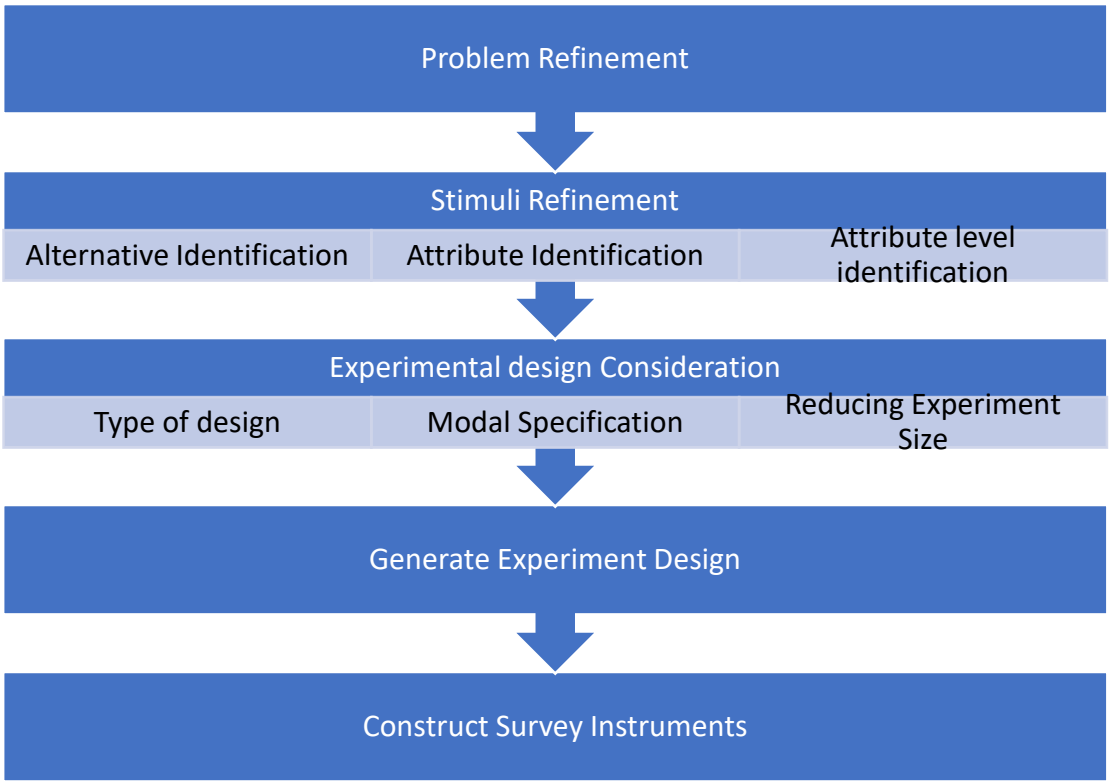

Figure 3. 2: Experimental Design Process *(Hensher, et al., 2005)*

The process begins with problem refinement such that analyst has assimilated sufficient understanding of the problem to proceed further.

3.2.1 Data Collection in RP Survey

The questionnaire in RP survey includes Socio-Economic and Trip characteristics, that influence Value of Travel Time Saving, which are as follows

1. Purpose: The categorical variable includes “Work”, “Study”, “Business”, “Recreation/Social Activity”, and “Others”. Generally, work trips have higher value of VTTS than recreational. These choices are prepared based on perception survey.
2. Distance: It includes in-vehicle travel distance between origin and destination. Generally, VTTS is directly proportional to distance.
3. Income: Generally, VTTS increases with income. For data collection, income is categorized into different groups.
4. Mode: This includes two choices “Private”, “Public”. Based on modes, value of travel time may differ.
5. Specific_Mode: It includes “Two-Wheeler” and “Four-Wheeler” categories for private mode and “Bus”, “Micro” and “Tempo” categories for public mode.
6. Reliability: Traveler attach value to travel time reliability. The categorical variable consists of two levels viz. “Inconsistent” and “Consistent”. This is addressed by assessing how often the destination is reached based on past experience.
7. Number_Of_Trips: The total number of trips made in a day are captured through this variable.
8. Cost: Cost includes travel cost i.e. fare for public vehicle users and perceived operation cost (fuel, maintenance, etc.) for private vehicle users.
9. Age: Age is categorized into different categories which later is converted into continuous variable using pseudo-random numbers in R.
10. In_Time: It is in-vehicle travel time for public vehicle users and nearly total travel time for private vehicle users.
11. To_Station: This continuous variable is the travel time that users of public vehicles spend to reach vehicle station before trip. It is considered zero for private vehicle users.
12. Waiting: This continuous variable is the travel time that users wait for transport after reaching the station. It is considered zero for private vehicle users.

13. From_Station: This continuous variable is the egress time required by traveler to reach destination from station after trip. It is considered zero for private vehicle users.
14. T_Time: It is total travel time i.e. sum of access/egress and in vehicle travel time.
15. Gender: This variable includes “Male” and “Female” categories.
16. Marital_Status: It represents marital status as “Married” or “Unmarried”.
17. Employment: This includes “Business”, “Government Job”, “Private Job”, “Self-Employment”, “Student” and “Unemployed”. People with different employment may have different value of travel time saving.
18. Veh_Owner: This includes ownership of vehicle as “Yes”, “No” or “Provided by Office”.
19. Time_of_Day: The value of travel time may differ with time of the day.
20. Earner: This variable represents number of employed members of family.

3.2.2 Hypothetical Alternative Choices for SP survey

Alternative, alternative and attribute level identification constitute second stage of experimental design process i.e. refinement of stimuli. The respondents have two alternatives i.e. mode with current parameters and mode with different parameters. Attributes, taken into consideration, are in-vehicle travel time, travel cost and reliability with two levels in each attribute. Different levels of attributes are selected for private vehicle users and public vehicle users as in-vehicle travel speed, perceived cost (fare) are different for public and private vehicle users.

Based on perception survey, travel speed for public transport is 15km/hour. 20 km/hour (15km/hour to 25km/hour) was adopted as normal operating speed for regular bus. Another speed was adopted as 30 km/hour, upper limit as prescribed by Nepal Urban Road Standard. Normal operating speed of BRT (20 km/hour to 40km/hour), LRT (20 km/hour to 45 km/hour) and RRT (25 km/hour to 60km/hour) fall under same speed of 30 km/hour (Vuchic, 2007). The fares of different modes are considered while making levels for attributes.

Table 3. 1 presents the fares of different modes in India namely, non-ac bus, bus rapid transit and metro based on (The cost of urban commute,2019). This study estimates the cost level based on these fares.

Table 3. 1: Estimation of cost level (Public Transport)

Distance	Delhi Metro Fare 2017 (Rs)	BRT Ahmedabad Fare 2013 (Rs)	non-AC bus BMTC fare	BRT fare compared to non-AC	Metro fare compared to BRT	Metro fare as compared to non-AC
0km-2km	10	4	5	0.80	2.50	2.00
2km-4km	20	9	9	1.00	2.22	2.22
4km-6km	30	11	12	0.92	2.73	2.50
6km-9km	30	15	15	1.00	2.00	2.00
9km-12km	30	20	16	1.25	1.50	1.88
12km-15km	40	20	17	1.18	2.00	2.35
15km-18km	40	22	18	1.22	1.82	2.22
18km-21km	40	25	20	1.25	1.60	2.00
21km-24km	50	25	21	1.19	2.00	2.38
24km-27km	50	27	21	1.29	1.85	2.38
27km-30km	50	27	22	1.23	1.85	2.27
30km-33km	50	27	23	1.17	1.85	2.17
33-36km	60	27	25	1.08	2.22	2.40
			Mean	1.12	2.01	2.21

Table 3. 2 presents the levels and attributes used in generation of hypothetical alternatives after adjusting for inflation and assuming reasonable value of fare.

Table 3. 2: Attribute and level (Public Transport)

Attributes	**Level 1**	**Level 2**
Travel Time	Reduced by 25%	Reduced by 50%
Travel Cost	Increased by 25 %	Increased by 50%
Reliability	Reliable	Non-reliable

Table 3. 3 presents full factorial design for public transportation resulting in formation of 8 alternatives.

Table 3. 3: Full factorial design for public transport

Alternative	Travel time reduction by	Travel cost increase by	Reliability
1	25%	25%	Non-reliable
2	25%	25%	Reliable
3	25%	50%	Non-reliable
4	25%	50%	Reliable
5	50%	25%	Non-reliable
6	50%	25%	Reliable
7	50%	50%	Non-reliable
8	50%	50%	Reliable

For private vehicle user, speed is calculated as 21.29 km/hour. According to Nepal Urban Road Standard, recommended design speed for collection and sub arterial road is 20-30 km/hour and 30-40 km/hour respectively which is taken into consideration during formation of levels for travel time. For levels of cost attributes, different approach needs to be considered.

Fuel consumption is one of the costs incurred while using private vehicle and fuel consumption decreases with increase in speed up to a point and then increases (Errampalli, et al., 2015). Fuel consumption is greater in congested case (Level of Service D, E and F) compared to steady state. (MRCU-MAINTENANCE REHABILITATION CO-ORDINATION, 2001) recommended equations to compute fuel costs, aside different components of vehicle operating cost, for passenger car, utility vehicles, large buses and trucks, but not for two-wheelers, operating in Nepal. *Table 3. 4* presents fuel consumption of two-wheeler, four-wheeler based on equations for fuel consumption provided by (Errampalli, et al., 2015) when congested and travelling freely. The equation for fuel consumption is in the form of for steady state

$$Fuel\ consumption = a + \frac{b}{v} + c * v^2 + d * Roughness + e * Rise - f * fall$$

Where,

Fuel Consumption is in ml/km

v = speed in kmph

a = constant specific to vehicle type

b = coefficient for inverse of velocity

c = coefficient for velocity squared

d = coefficient for roughness of road

e = coefficient for rise in road

f = coefficient for fall in road

Neglecting roughness (mm/km), rise (m/km) and fall (m/km), fuel consumption is calculated. Also fuel consumption at congestion is obtained by multiplying steady state consumption by a factor.

Table 3. 4 Fuel Consumptions at different speed

Vehicle	Speed (km/hour)	Fuel Consumption (ml/km)		Km/liter	
		Steady	Congested	Steady	Congested
Two-Wheeler	20	32.60	43.22	30.67	23.14
	25	28.09	33.86	35.60	29.53
	30	25.62	28.46	39.03	35.14
	35	24.42	25.41	40.95	39.35
Small Car	20	73.40	101.85	13.62	9.82
	25	65.64	84.21	15.23	11.87
	30	60.84	72.61	16.44	13.77
	35	57.79	64.67	17.30	15.46
Big Car	20	84.30	151.69	11.86	6.59
	25	74.53	119.80	13.42	8.35
	30	68.05	98.03	14.69	10.20
	35	63.47	82.41	15.76	12.13

(Brons, et al., 2008) evaluated short run and long run price elasticity of gasoline demand to be -0.34 and -0.84 respectively. In short-run, people demand less quantity of gasoline but in long run, fuel efficient vehicles, change in travel pattern etc. contribute to higher long run demand elasticity. Increase in fuel price (by any means like fuel tax) leads to lesser quantity demanded which in turn may lead to lesser vehicles in the road. Lesser

vehicle implies higher cruising speed and reduced fuel consumption and thus may offset the impact of increased fuel price. Many a mechanism can lead to such rebound effect.

(OECD, 2018) in a report published tax on unleaded gasoline and total tax as percentage of total price resulted in mean value of 55.15% implying fuel tax to be higher than ex-tax price in some countries. *Figure 3. 3* exhibits fuel tax as percentage of total fuel cost based on the report.

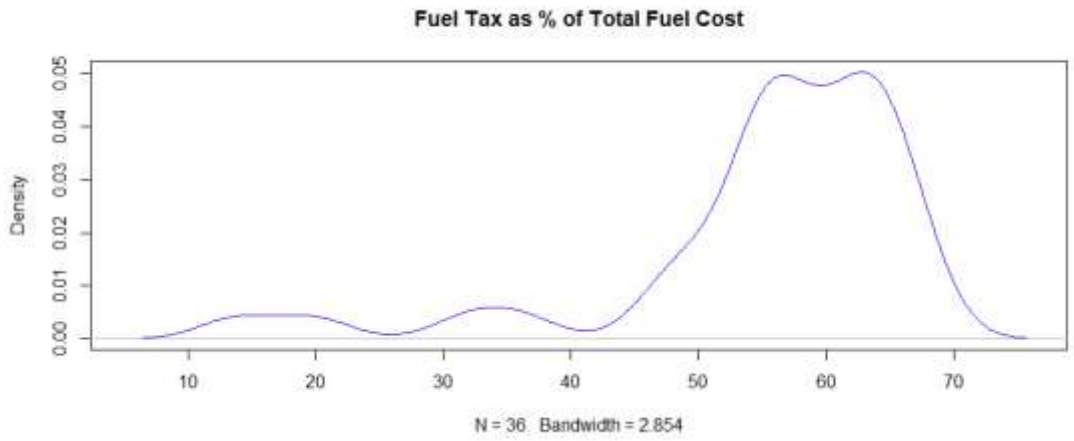

Figure 3. 3: Fuel tax as % of Total Fuel Cost

For formulation of alternatives a reasonable increase of 20% and 40% is considered. *Table 3. 5* shows the attributes and levels used in formulation of hypothetical alternatives for private vehicle users.

Table 3. 5: Attributes and levels (Private)

Attributes	**Level 1**	**Level 2**
Travel Time	Reduced by 20%	Reduced by 40%
Travel Cost	Increased by 20%	Increased by 40%
Reliability	Reliable	Non-Reliable

Table 3. *6* exhibits full factorial design considering all the attributes and all the levels for private vehicle user.

Table 3. 6: Full factorial design for private vehicle users

Alternative	Travel time reduction by	Travel cost increase by	Reliability
1	20%	20%	Non-reliable
2	20%	20%	Reliable
3	20%	40%	Non-reliable
4	20%	40%	Reliable
5	40%	20%	Non-reliable
6	40%	20%	Reliable
7	40%	40%	Non-reliable
8	40%	40%	Reliable

Third stage of experimental design process is experimental design consideration. *Table 3. 3* and *Table 3. 6* represent the full factorial design resulting in eight choice sets. Higher number of alternatives, choice sets, results in better information if the responders make choice after deliberate consideration. With increased number of choices, it is not likely that each choice is considered with same deliberation. Associating reliability with higher cost, those alternatives with high cost and reliability are adopted. Four choice sets are formed for Stated Preference survey.

Table 3. 7 and *Table 3. 8* portray the alternatives for private vehicle user and public vehicle users respectively. Hypothetical alternatives are denoted as Alternative 1, Alternative 2, Alternative 3, and Alternative 4. Each row in table are hypothetical alternatives and when paired with current, presently used, mode result in choice set. Thus, an individual respond to four choice sets.

Table 3. 7: Final alternatives for public vehicle user

Alternative	Travel time reduction by	Travel cost increase by	Reliability
1	50%	50%	Reliable
2	25%	50%	Reliable
3	25%	25%	Non-reliable
4	50%	25%	Non-reliable

Table 3. 8: Final alternatives private vehicle user

Alternative	Travel time reduction by	Travel cost increase by	Reliability
1	40%	40%	Reliable
2	20%	40%	Reliable
3	20%	20%	Non-reliable
4	40%	20%	Non-reliable

Table 3. 9 presents a choice set presented to an individual, i.e. public transportation user, when current alternative is paired with alternative 1 of *Table 3. 7*.

Table 3. 9: A sample choice set

Attribute	In-vehicle travel time	Travel Cost	Reliability	Choice
Presently Used Mode	Current	Current	Current	
Alternative 1	Reduced by 50%	Increased by 50%	Reliable	

The questionnaire, attached in Appendix B and C, constitutes the final stage survey instruments.

3.2.3 Determination of sample size for survey.

Sample size when determined adopting the same methodology as in perception survey results in minimum sample size of 384.

For SP choice data, number of observations necessary to estimate robust model governs minimum sample size. The minimum degree of freedom required for estimation purpose is number of parameters to be estimated and an additional degree of freedom. (Hensher, et al., 2005) suggest 50 observations as cut-off for least-popular alternative. When the parameters to be estimated are generic, minimum sample size can be relaxed.

Observations from 450 individuals is collected in RP/SP survey of which 46 is discarded due to incomplete answers.

3.3 Analysis Framework

For RP survey data, "VGAM" package is adopted whilst "mlogit" package for SP choice data in statistical software R.

3.3.1 Logit Model Formulation

3.3.1.1 Multinomial Logit Model

The model is based on Random Utility Theory. The utility associated with each alternative *j*, as evaluated by each individual *q* is written as:

$$U_{jq} = \sum_{k=1}^{K} \beta_{jk} x_{jkq} + \varepsilon_{jq}$$

The first part includes systematic part of utility function represented as V_{jq} while ε_{jq} random or unobserved component of utility. β is parameter related to observed variables *x*. The probability that an individual *q* chooses alternative *i* is:

$$P_{iq} = Probability\ (V_{iq} + \varepsilon_{iq} > V_{jq} + \varepsilon_{jq} \quad \forall j \neq i)$$

$$= Probability\ (\varepsilon_{jq} < \varepsilon_{jq} + V_{iq} - V_{jq} \quad \forall j \neq i)$$

For Multinomial logit model, ε_{jq} among alternatives are Independently and Identically Distributed (IID) with Gumbel distribution i.e. IID extreme. The model assumes Independence of Irrelevant Alternative (IIA). The choice probability formula takes a closed form (Train, 2009).

The probability is given as:

$$P_{iq} = \frac{e^{V_{iq}}}{\sum_j e^{V_{jq}}}$$

3.3.1.2 Mixed Logit Model

Standard logit model does not address random taste variation, unrestricted substitution pattern (i.e. it requires Independence of Irrelevant Alternative) and correlation in unobserved factor over time. Mixed logit model obviates the limitations of standard logit model (Train, 2009).

Mixed logit probabilities are integrals of standard logit probabilities over a density of parameters.

$$P_{iq} = \int L_{iq}(\beta) f(\beta) d\beta$$

Where,

$L_{iq}(\beta)$ is typically logit probability evaluated at parameters β:

$$L_{iq} = \frac{e^{V_{iq}(\beta)}}{\sum_j e^{V_{jq}(\beta)}}$$

and $f(\beta)$ is density function, $V_{iq}(\beta)$ is a portion of utility, which depends on parameters β. Thus, mixed logit model is mixture of logit function evaluated at different β with $f(\beta)$ as mixing distribution. The resulting integral in choice formula does not have a closed form and is evaluated numerically through simulation (Train, 2009).

The utility associated with each alternative j, as evaluated by each individual q can be written as:

$$U_{jq} = \sum_{k=1}^{K} \beta_{jk} x_{jkq} + \varepsilon_{jq}$$

Where β is parameter or coefficient, related to observed variables x, representing person's taste varying with density $f(\beta)$. ε_{jq} is IID extreme value. $f(\beta)$ can be specified as normal, lognormal, uniform, triangular or zero-censored normal.

The utility equation could also be written as:

$$U_{jq} = \sum_{k=1}^{K} \alpha_{jk} x_{jkq} + \sum_{k=1}^{K} \mu_{jk} z_{jkq} + \epsilon_{jq}$$

Where, z and x are observed variables, α is fixed coefficient, μ is random term with zero mean, ε_{jq} is distributed IID extreme. Last two terms are unobserved portion, simply put

error term, of utility can be correlated over alternatives depending on specification of *z*.

3.3.2 Estimation of Model

The models are generally estimated using maximum likelihood method. Probability an individual *q* selecting an alternative *j*, one he/she already chose is

$$\prod_{j=1}^{J}\left(P_{jq}\right)^{y_{jq}}$$

Where, y_{jq} equals unity if individual *q* chose alternative *j* else assumes zero.

For each individual in sample, probability (likelihood) of each individual selecting the alternative he/she already chose is

$$L(\beta) = \prod_{q=1}^{Q}\prod_{j=1}^{J}\left(P_{jq}\right)^{y_{jq}}$$

where β represents parameters. The log-likelihood function is then defined as:

$$LL(\beta) = \sum_{q=1}^{Q}\sum_{j=1}^{J} y_{iq} ln\left(P_{jq}\right)$$

And estimator is value of β that maximizes this function. For linear in-parameter utility equation, $LL(\beta)$ is globally concave. At maximum value of this function, its derivative with respect to each of the parameters is zero.

3.3.3 Estimation of VTTS

Value of travel time is estimated as ratio of time coefficient to cost coefficient in the utility equation. Reliability is denoted by 0 for not reliable and 1 for reliable. Let the attributes be:

- Travel time TT [in hour]
- Travel Cost TC [in Rupees]

- Travel Time reliability TR [0 for reliable or 1 for non-reliable travel time]

The utility function has the form

$$U_t = \beta_c TC + \beta_t TT + \beta_r TR + \varepsilon$$

The parameters are estimated by maximum likelihood method. The ratio β_t / β_c gives VTT. Similarly, ratio of reliability parameter and cost parameter results in value of travel time reliability.

3.3.4 Goodness of Fit

ρ^2, informal goodness of fit, likelihood ratio index, Pseudo R^2 is often used in discrete choice models to assess how well the model fits the data.

$$\rho^2 = 1 - \frac{LL(\beta)}{LL(0)}$$

Where, *LL(β)* is value of log-likelihood function at estimated parameters and *LL(0)* is its value when all parameters are set to zero.

Though likelihood ratio index and R^2 used in regression have same range i.e. 0 to 1, their interpretation is not similar. R^2 used in regression explains percentage of variation in the dependent variable explained by independent variable. In general, ρ^2, does not have interpretable meaning for values lying between 0 and 1. For different models with same data and same set of alternatives, higher value generally implies better fit (Train, 2009). Though the interpretation is not similar, values of ρ^2 between 0.2 and 0.4 are equivalent to R^2 values of 0.7 to 0.9 for linear regression (Louviere, et al., 2000).

3.3.5 Hypothesis testing

Tests are performed to test the null hypothesis that estimated parameters are equal to zero or each other.

H_0: $\beta = \beta_0$

H_1: $\beta \neq \beta_0$

Likelihood ratio test:

Likelihood ratio test assesses the goodness of between two statistical model. It is calculated as $-2(LL(\beta)-LL(\beta_0))$ where LL represents log-likelihood and follows χ^2 distribution.

Score Test (Lagrange Multiplier Test):

Score test assesses whether a restriction imposed on model by maximum likelihood is violated by data. The statistics to test null hypothesis is $S(\beta_0)^2 / I(\beta_0)$ where, $S(\beta)$ represents partial derivative of likelihood function with respect to parameter and $I(\beta)$ is Fischer information. The test statistics has χ^2 distribution.

Wald Test:

The test assesses null hypothesis based on weighted distance between estimates. The test statistics follows χ^2 distribution under null hypothesis.

3.3.6 Analysis Tools (Packages)

VGAM

"VGAM provides functions for fitting vector generalized linear and additive models and associated models." (Yee, 2020). The package adopts maximum likelihood estimation (MLE) or penalized MLE to fit many models. *vglm()* function is used for estimation of multinomial logit model on RP data.

mlogit

"mlogit" package is adopted for the modelling of stated preference data. For the analysis purpose, the package requires data to be in *long* format. For the analysis of SP data *mlogit()* function is used. The package allows for normal ("n"), log-normal ("ln"), zero-censored normal ("cn"), uniform ("u") and triangular ("t") distribution of random variables (Croissant, 2019). The model is estimated based on random draws, rather than Halton draws, adopting panel data version of log-likelihood.

CHAPTER 4 ANALYSIS OF DATA

4.1 ANALYSIS OF DATA FROM PERCEPTION SURVEY

Simple descriptive statistics is used for analysis of data obtained from perception survey.

Figure 4. 1 summarizes the collected data, on categorical variables viz. purpose of trip, mode of trip and willingness to pay for reduced in-vehicle travel time, from perception survey. In data collected on 384 individuals, work trips (half) and study trips (quarter) comprised nearly three-fourth of total trips made. Among respondents a little below three-fifth used private vehicle and rest public vehicles. Up on asking respondents' willingness to pay for reduced in-vehicle travel time, two-fifth, three-tenth and rest of respondents replied yes, no and maybe respectively. Willingness to pay for reduced in-vehicle travel time is the basis of the study.

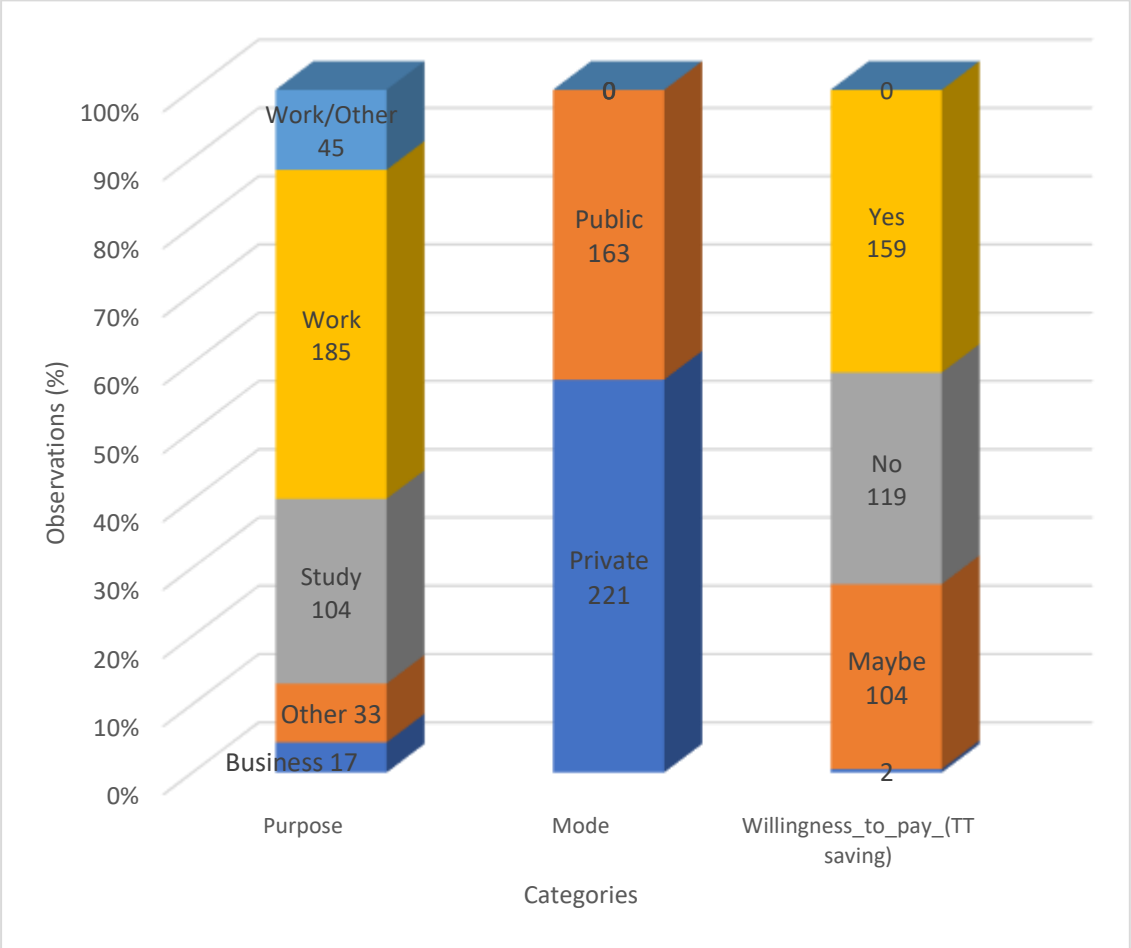

Figure 4. 1: Summary of Categorical Data (Perception Survey)

Figure 4. 2 summarizes the response of respondents on willingness to pay for other factors except travel time. Bars represent the combination of different factors as an aggregate response. Most respondents responded safety followed by combination of comfort, safety and reliability.

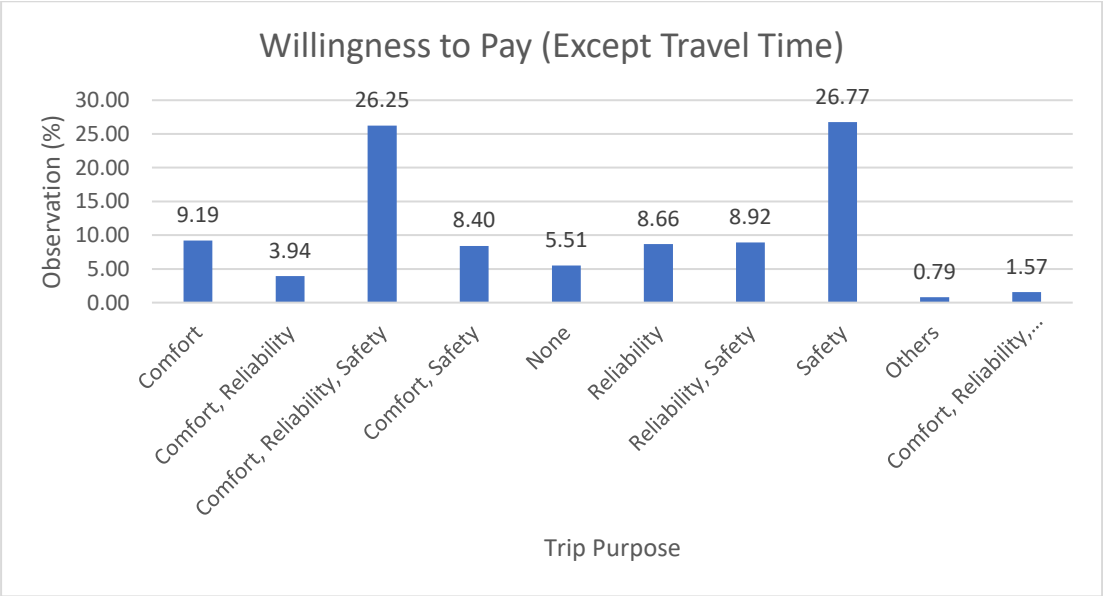

Figure 4. 2: Willingness to Pay (Except for Travel Time)

Figure 4. 3 simplifies *Figure 4. 2*. Though many travelers preferred safety, safety was not accounted in formulation of choice as it is difficult to quantify. Despite reliability and comfort showing similar proportion, comfort is not included in formation of alternatives for the same reason as safety.

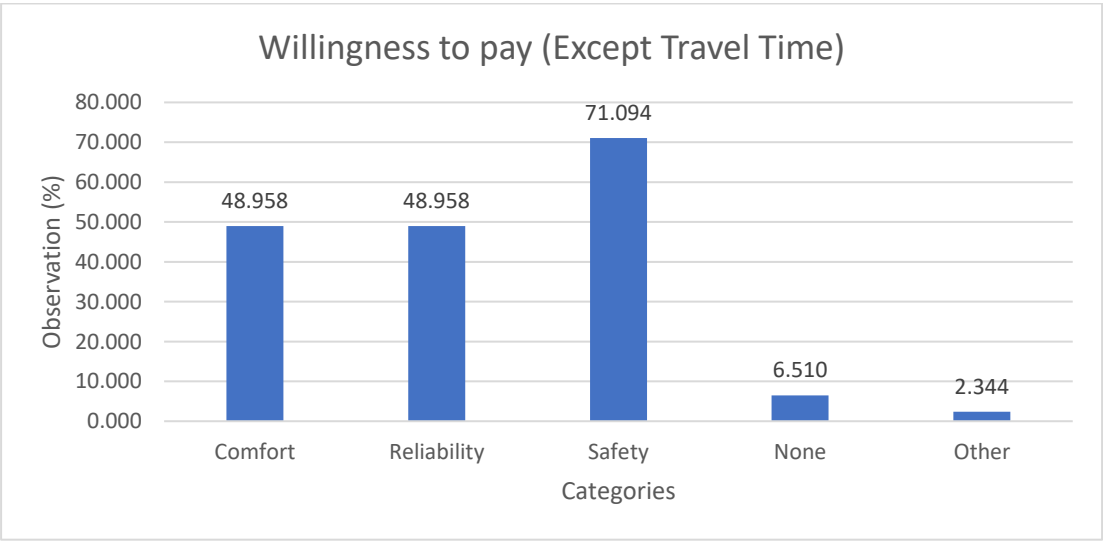

Figure 4. 3: Willingness to pay (Except Time Travel by Category)

Figure 4. 4 demonstrates travel distance in km by trip purpose. The bars represent upper, mean and lower level respectively. This is used in calculating in-vehicle speed taken as basis for evaluating levels in travel time.

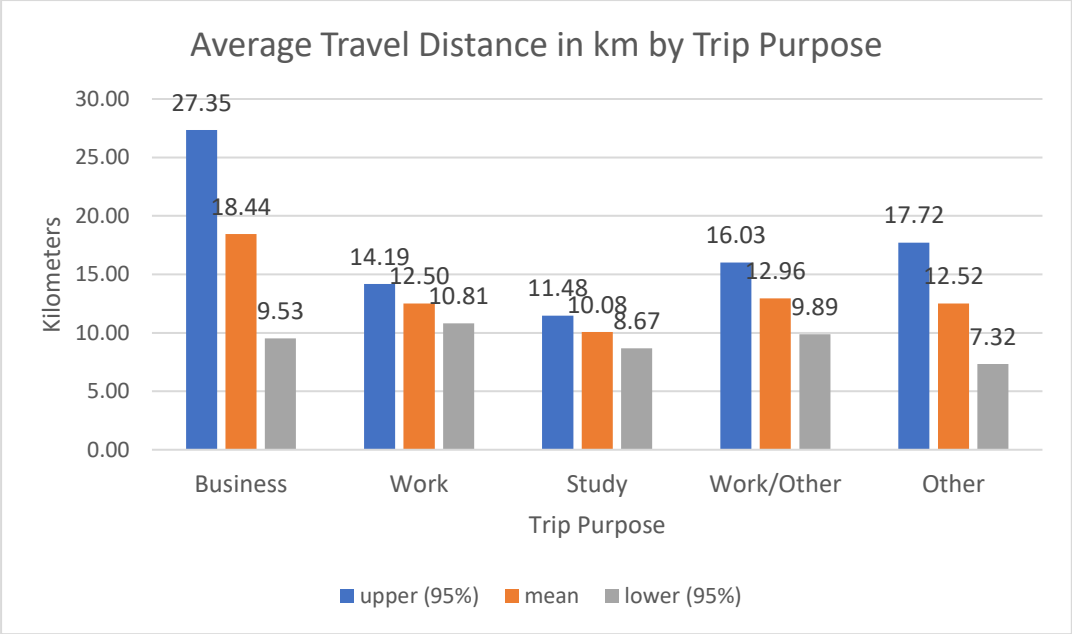

Figure 4. 4: Average Travel Distance in km by Trip Purpose

Figure 4. 5 represents ratio of maximum travel time to average travel time by trip purpose. This acts as an indirect measure of reliability.

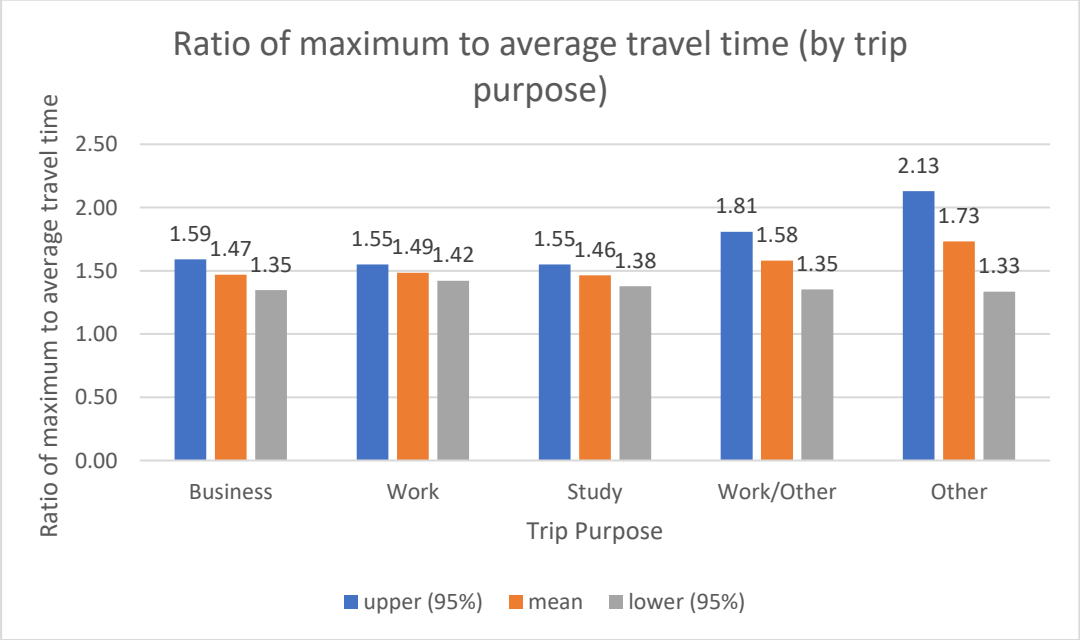

Figure 4. 5: Ratio of maximum to average travel time (by trip purpose)

Figure 4. 6 represents perceived travel cost, per trip, by private user. Most of the user perceive fuel cost travel cost followed by operation and maintenance, yearly tax and initial investment. For some private user the cost bearer could be office, and this could explain fuel cost not perceived by all users.

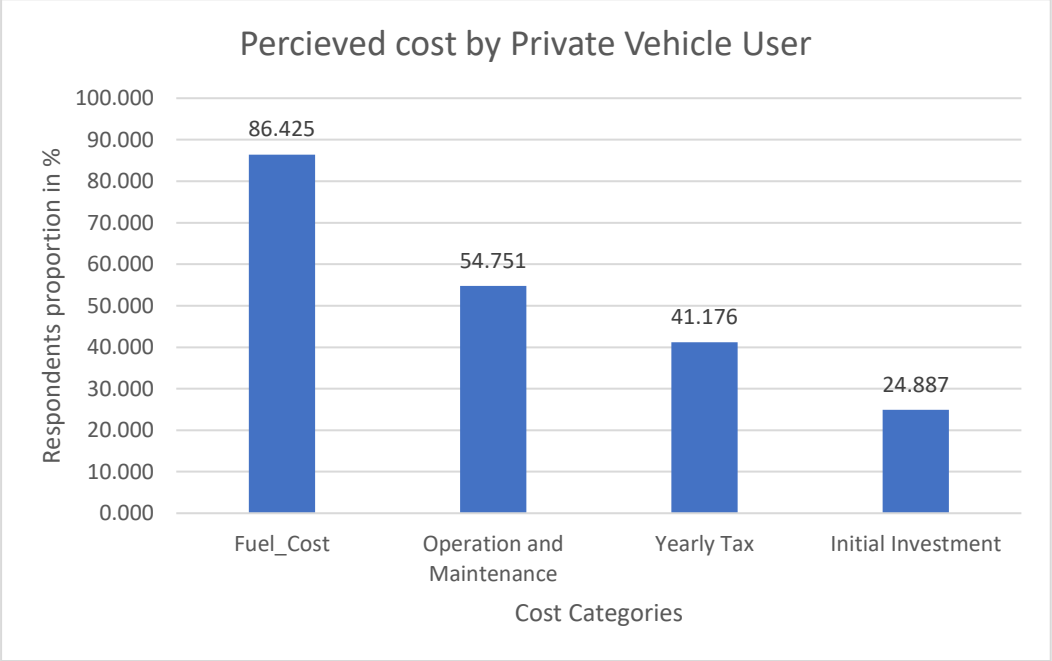

Figure 4. 6: Perceived cost by Private Vehicle User

Figure 4. 7 represents cumulative frequency distribution of in-vehicle travel speed for private vehicle users.

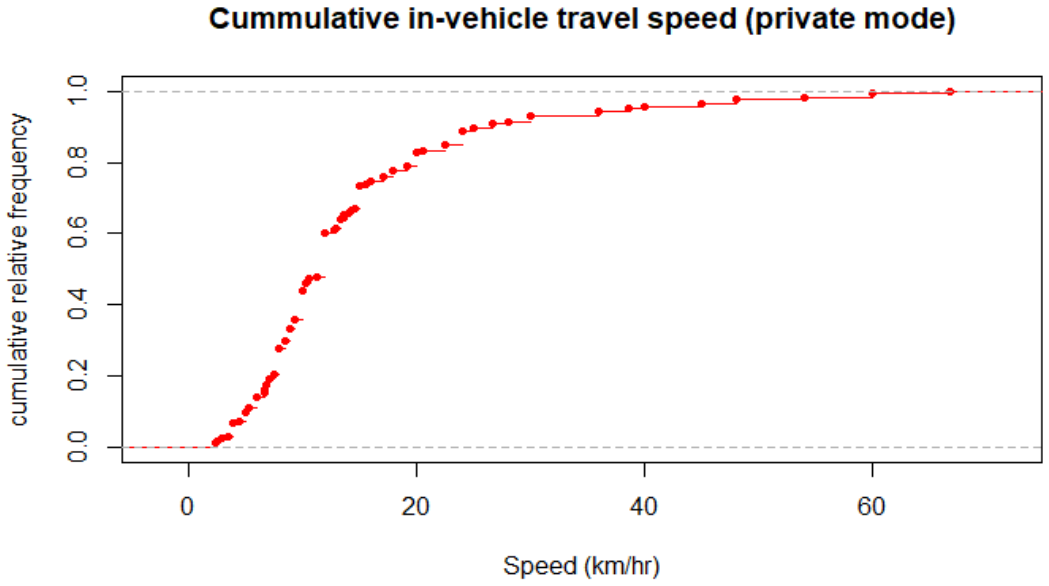

Figure 4. 7: In-vehicle speed (Private Mode)

In-vehicle travel speed is 21.29 km/hour with 19.49 km/hour and 23.10 km/hour respective lower bound and upper bound (95% confidence interval) for private vehicle user.

Figure 4. 8 represents cumulative frequency distribution of in-vehicle travel speed for public vehicle. In-vehicle travel speed is 15.00 km/hour with 13.12 km/hour and 16.88 km/hour respective upper bound and lower bound (95% confidence interval) for public mode.

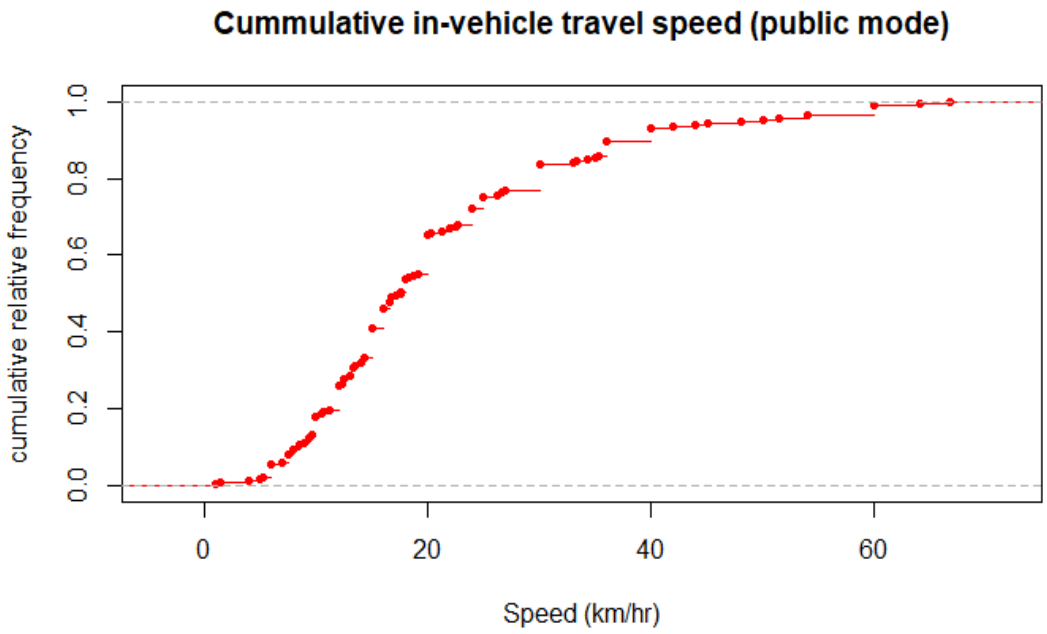

Figure 4. 8: In-vehicle travel speed (Public Transport)

The obtained speed is used in formulation of hypothetical alternatives in questionnaire.

Figure 4. 9, *Figure 4. 10* and *Figure 4. 11* summarize the cross-tabulation data of travel mode and trip purpose of the respondent with different response to willingness to pay for reduced in-vehicle travel time viz. yes, no and maybe respectively. X-axis represents trip purpose and width of bar represents relative proportion of the trip purpose. Y-axis represents travel mode within each trip purpose and height relating to mode share.

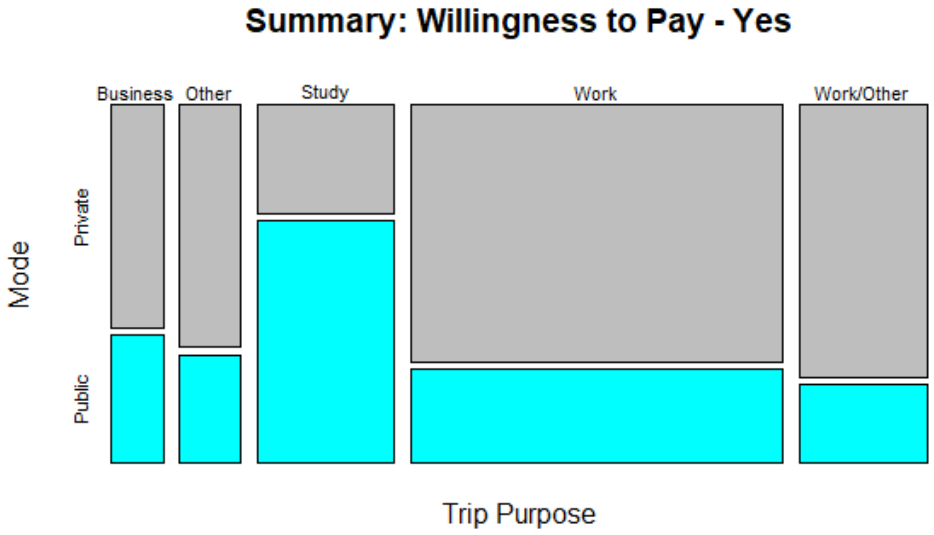

Figure 4. 9: Summary: Willingness to Pay for reduced travel time - Yes

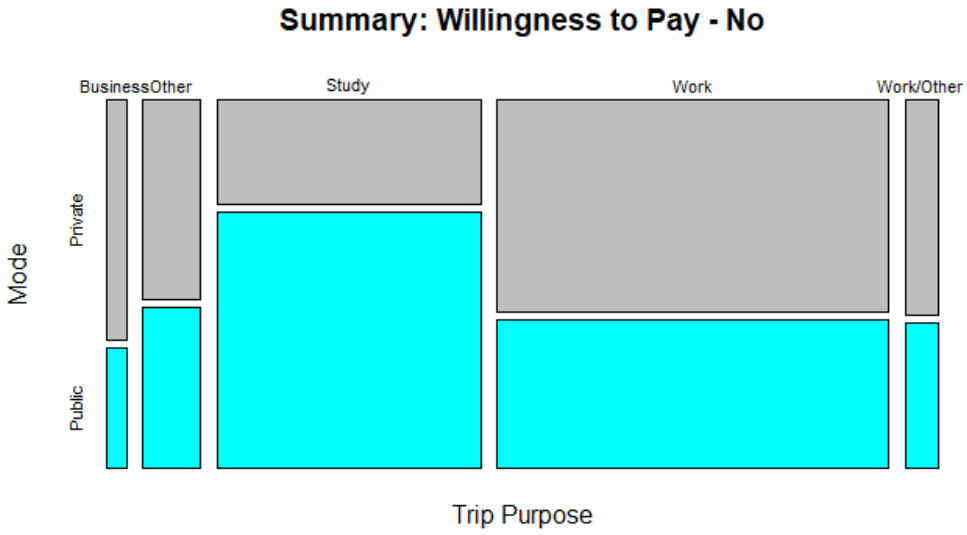

Figure 4. 10: Summary: Willingness to Pay for reduced travel time – No

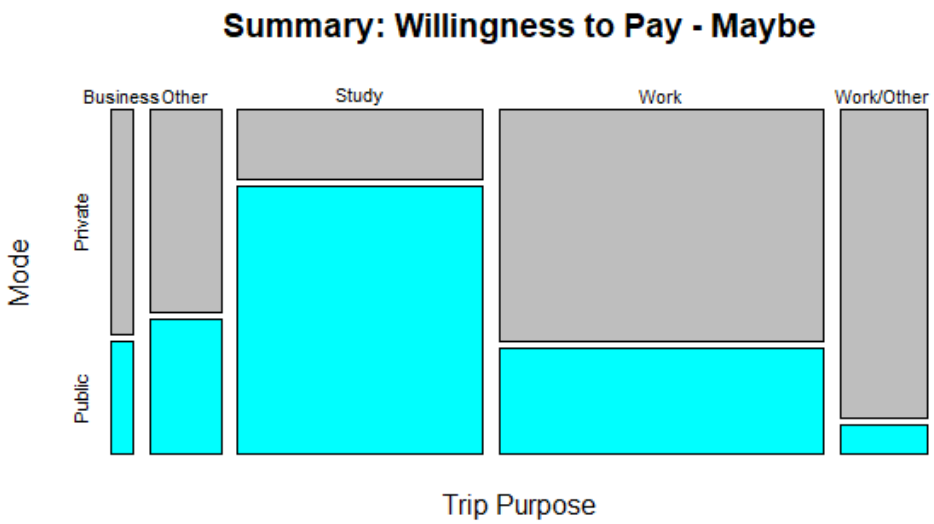

Figure 4. 11: Summary: Willingness to Pay for reduced travel time - Maybe

Based on *Figure 4. 9*, *Figure 4. 10* and *Figure 4. 11*, respondents with study trip purpose have less willingness to reduce in-vehicle travel time. For other trip purpose and corresponding mode, observations are inconclusive.

4.2 ANALYSIS OF RP/SP SURVEY DATA

4.2.1 Summary of Observed Data

Figure 4. 12 presents the summary of categorical data obtained in RP/SP survey. The stacked bars represent observation within each category. The figures in the bars represent absolute number of observations within each category viz. mode, gender, marital status, age, employment, monthly income, vehicle ownership, specific mode (i.e. two-wheeler, four-wheeler, bus, micro bus and car), travel time reliability and trip purpose. The ordinate represents the observation as percentage. Mode share of private and public vehicles is almost equal. Work and study comprise majority of trips. Travel time is unreliable for about three-fifth of the responders. Majority of the responders, within each category, are male, unmarried and younger than 35 years. The responders are almost uniformly distributed among different income groups. The data is used for model estimation purpose for RP data.

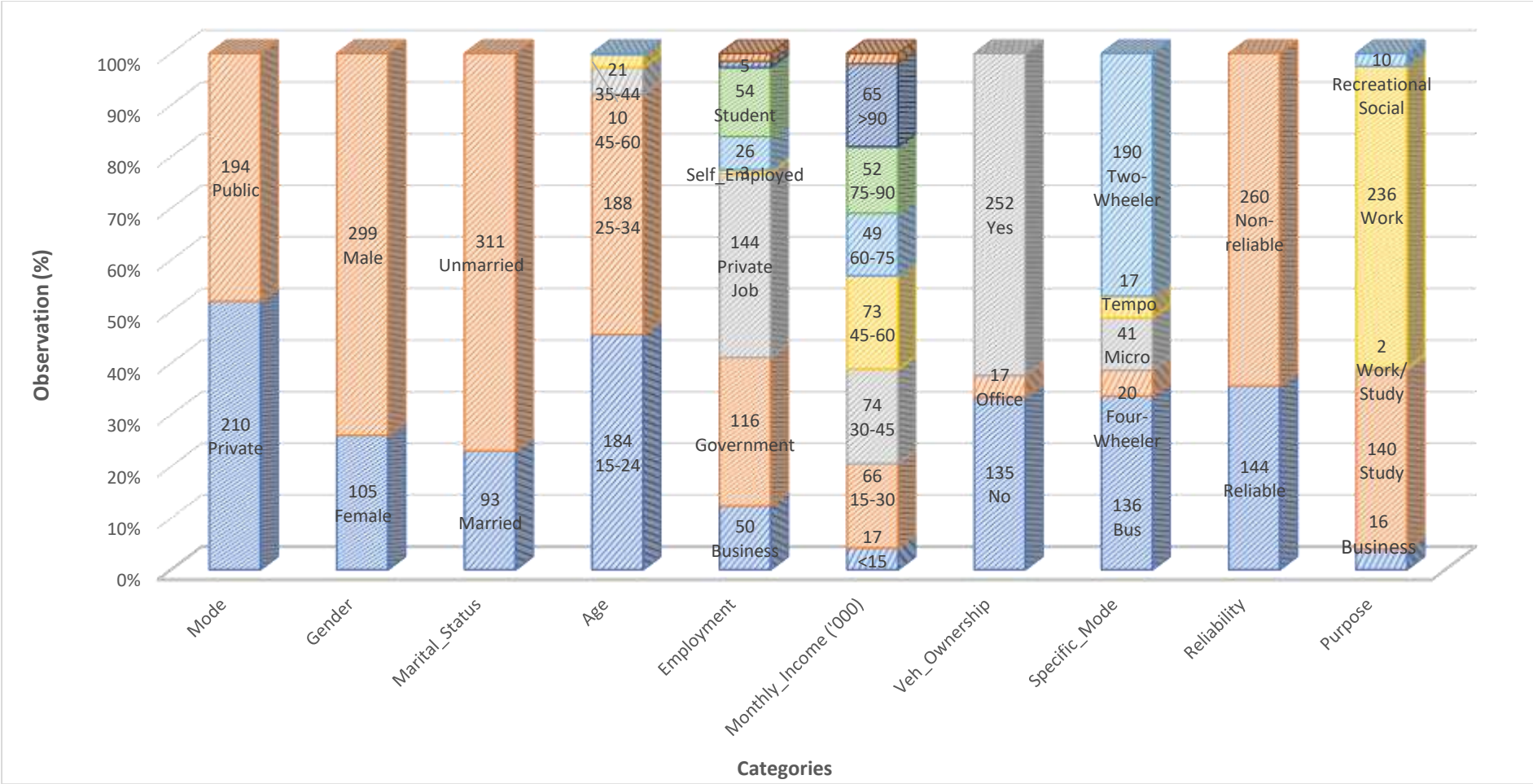

Figure 4. 12: Summary of Categorical Data (RP/SP Survey)

4.2.2 Estimation of VTTS from Revealed Preference

The multinomial logit model is developed with different variables taking "Public Transport" as reference category. Total travel time including access/egress time is used for modelling purpose. For use of mixed logit model for RP data, information on values of alternative variant regressor (trip characteristics) for each and every mode for each individual is required. For within city trip, a public vehicle user might not be aware of the travel time, travel cost, reliability of private modes and vice versa complicating data collection. Thus, multinomial logit model was adopted for RP data.

The summary of the model is in *Table 4. 1*. The coefficients except reliability are significant. Travel cost variable has positive coefficient implying higher utility of private mode compared to public transport for unit increase in travel cost. In general, utility of a mode decreases with increase in cost and the result is contrasting which could be due to omission of variables specific to private modes. The utility of private mode decreases with increase in travel time which is as expected. Since, reliability is not significant predictor in this model, it does not add to the utility.

Table 4. 1: Model from RP data

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**	**Significance Codes**
(Intercept)	1.7167	0.3880	4.4244	0.0000	***
Cost	0.0365	0.0064	5.7188	0.0000	***
ReliabilityInconsistent	-0.0396	0.3084	-0.1285	0.8977	
T_Time	-0.0697	0.0083	-8.4175	0.0000	***
	VTTS (Rs. per hour) =	Rs. 114.65			
	Log-Likelihood =	-101.065			
	Pseudo R^2 =	0.6386			

The revealed preference data results in VTT as Rs. 114.65 per hour.

4.2.3 Estimation of VTT from Stated Preference Method

The observation from questionnaires after being entered in excel is imported to R. Data imported in *wide* format is converted to *long* format for analysis. Two rows make the choice made by an individual in a hypothetical scenario.

In-vehicle travel time, travel cost and travel time reliability is considered during analysis for SP observations. Multinomial logit model, uncorrelated random parameter mixed logit model and correlated mixed logit model are formulated using "mlogit" package in R. For mixed logit models, after trials with different distribution, time and reliability is considered random with normal distribution.

Likelihood ratio test is performed or comparison of correlated mixed logit model and multinomial logit model and then correlated mixed logit model and uncorrelated mixed logit model. Score test is performed on correlated and then non-correlated model. Wald test is performed on mixed logit model setting correlation true and then false. Linear hypothesis test is performed to check if elements of correlation matrix are zero. The tests elucidated the presence of randomness but not correlation.

Positive signs are expected for coefficients. Increase in variable reliability implies less reliability in terms of travel time reliability. The coefficients cannot be interpreted directly, but dividing them by the price coefficient, monetary values are obtained. Though the coefficients are random, obtained values are mean values aggregated among respondents.

Public Vehicle User Only

Table 4. 2 summarizes the logit model for public vehicle users only. As the reliability coefficient is not significant, modelling was done excluding reliability presented in *Table 4. 3*. Though the coefficients are positive and significant, the Pseudo R^2 decreased from 0.154 to 0.1299 and VTT increased to Rs. 71.19 per hour from Rs. 67.48 per hour. Since the model including all three attributes has higher pseudo R^2 value, it is adopted.

Time and price coefficients are significant and have positive sign as predicted. The value of travel time for public vehicle users is Rs. 67.48 per hour. As the reliability coefficient is not significant, no value could be attached to travel time reliability. This could be due to in-vehicle travel time being a part of total journey time.

Table 4. 2: Model: Public Vehicle Users Only (Including Reliability)

	Estimate	Std. Error	z-value	Pr(>|z|)	
price	0.0975	0.0287	3.4013	0.0007	***
time	6.5763	1.4371	4.5761	0.0000	***
reliability	0.0659	0.2278	0.2893	0.7724	
Log-Likelihood		-454.46			
Pseudo R^2		0.154			
VTT (Rs./hour)		67.48			

Table 4. 3: Model: Public Vehicle Users Only (Excluding Reliability)

	Estimate	Std. Error	z-value	Pr(>|z|)	
price	0.0661	0.0171	3.8725	0.0001	***
time	4.7036	5.7655	5.7655	0.0000	***
Log-Likelihood		-467.54			
Pseudo R^2		0.1299			
VTT (Rs./hour)		71.19			

Private Vehicle Users (Two-Wheelers Only)

Table 4. 4 summarizes the model for private vehicle users (two wheelers only). Only reliability was set as random parameter. All the coefficients are significant and have positive sign as predicted . Dividing time coefficient by price coefficient results in the value of travel time for two-wheeler users as Rs. 112.39 per hour. Monetary value of Rs. 111.17 could be attached to increased reliability (i.e. consistent travel time for each trip).

Table 4. 4: Model: Private Vehicle - Two-Wheeler

	Estimate	Std. Error	z-value	Pr(>|z|)	
price	0.0189	0.0055	3.4557	0.0005	***
time	2.1193	0.8851	2.3945	0.0166	**
reliability	2.0963	0.5958	3.5186	0.0004	***
Log-Likelihood		-451.72			
Pseudo R^2		0.131			
VTT (Rs./hour)		112.39			
VOR (Rs.)		111.17			

Work Trip – Public Vehicle User

Table 4. 5 summarizes the model for work trips (public vehicle user). As the reliability coefficient is not significant, modelling was done without reliability which is presented in *Table 4. 6*. The model resulted in price coefficient as insignificant (p-value 0.05125) and lower value of pseudo R^2, so model including reliability is used.

Time and price coefficients are significant and have positive sign as predicted. The value of travel time for work trips (public vehicle user) is Rs. 129.42 per hour. As the reliability coefficient is not significant, no value could be attached to travel time reliability. This could be due to in-vehicle travel time being a part of total journey time.

Table 4. 5: Model: Work Trip - Public Vehicles (Including Reliability)

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**	
price	0.0811	0.0380	2.1364	0.0326	*
time	10.4931	3.0754	3.4119	0.0006	***
reliability	-0.5009	0.4306	-1.1632	0.2447	
Log-Likelihood		-186.97			
Pseudo R^2		0.169			
VTT (Rs./hour)		129.42			

Table 4. 6: Model: Work Trip - Public Vehicles (Excluding Reliability)

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**	
price	0.0425	0.0218	1.9493	0.0512	.
time	6.5390	1.4575	4.4864	0.0000	***
Log-Likelihood		-194.77			
Pseudo R^2		0.1334			
VTT (Rs./hour)		153.51			

Work Trip – Private Two-Wheeler User

Table 4. *7* summarizes the model for work trips (private two-wheeler vehicle users). All the coefficients are significant and have positive sign as predicted. The value of travel time for work trips (private vehicle user) is Rs. 129.64 per hour. Monetary value of Rs. 79.8 could be attached to increased reliability (i.e. consistent travel time for each trip).

Table 4. 7: Model: Work Trips - Private Two-Wheeler User

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**	
price	0.0345	0.0136	2.5324	0.0113	*
time	4.4741	2.0336	2.2001	0.0278	*
reliability	2.7542	0.7198	3.8265	0.0001	***
Log-Likelihood		-301.65			
Pseudo R^2		0.226			
VTT (Rs./hour)		129.64			
VOR (Rs.)		79.80			

Study Trip – Public Vehicle User

Table 4. *8* summarizes the model for study trips (public vehicle user). As the reliability coefficient is not significant, modelling was done excluding reliability presented in *Table 4. 9*. Though the coefficients are positive and significant, the Pseudo R^2 decreased from 0.1267 to 0.1041 and VTT from Rs 26.40 per hour to Rs. 19.98 per hour. Since the model including all three attributes has higher pseudo R^2 value, it is adopted.

All the coefficients are significant and have positive signs as predicted. The value of travel time for study trips (public vehicle only) is Rs. 26.40 per hour. As the reliability coefficient is not significant, no value could be attached to travel time reliability. This could be due to in-vehicle travel time being a part of total journey time.

Table 4. 8: Model: Study Trips - Public Vehicle User (Including Reliability)

	Estimate	Std. Error	z-value	Pr(>|z|)	
price	0.1453	0.0508	2.8612	0.0042	**
time	3.8357	1.5962	2.4030	0.0163	*
reliability	0.3340	0.2856	1.1693	0.2423	
Log-Likelihood		-245.25			
Pseudo R^2		0.1267			
VTT (Rs./hour)		26.40			

Table 4. 9: Model: Study Trips - Public Vehicle User (Excluding Reliability)

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**	
price	0.1073	0.0350	3.0663	0.0022	**
time	2.1432	1.0336	2.0735	0.0381	*
Log-Likelihood		-251.61			
Pseudo R^2		0.1041			
VTT (Rs./hour)		19.98			

Except model consisting of public transport users, reliability is a significant variable. The pseudo R^2 value seems acceptable. Value of travel time for different income group was performed and the value of travel time was comparable. The work trips had higher value of travel time than other purpose.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Transportation investments are done to improve/increase accessibility and mobility of people. Transportation investments being capital intensive, the investments are quite difficult to justify using cost-benefit analysis. Value of travel time saving due to investment could be a key portion of monetized benefit. Though, vehicle operating cost and value of travel time are used in project appraisal, value of travel time used is based on wage rate. In absence of research connecting wage rate and value of travel time in Nepal, Value of Travel Time Saving for Commuters in Kathmandu valley based on RP/SP approach, which the research aims to provide, could be useful to appraise the investments.

The paper estimates the value of travel time saving of commuters in Kathmandu valley applying RP/SP approach. VTT from PR survey resulted in Rs. 114.73 per hour. VTT from SP survey resulted in Rs. 67.48 per hour and Rs. 112.38 per hour for public vehicle user and private two-wheeler user. VTT for work trips was estimated as Rs. 129.64 per hour and Rs. 129.42 per hour for private vehicle user and public vehicle users respectively depicting higher value for work trips. VTT from survey resulted in Rs. 22.40 per hour for study trips for public vehicle users. A number of trips for study purpose being made in public transport could be the reason VTT for public vehicle user being a bit low compared to others. The obtained value of travel time could be used in decision making process while appraising projects.

5.2 RECOMMENDATIONS

The following could be looked into in further studies.

- Study considering the factors like comfort and safety.
- Use of correlated mixed logit models.
- Impact of attitudinal variables on parameters like cost, time, reliability, etc.
- Value of Travel Time as function of wage rate.

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APPENDIX A: Questionnaire for Perception Survey

Perception Survey

This form is for perception survey for thesis (in MSc in Transportation Engineering)

1 औसतमा, एक दिनमा तपाईंले कति पटक एकतर्फी यात्रा गर्नुहुन्छ ?
……

2 सामन्यतया, यस्तो यात्राको उद्देश्य के रहन्छ ?
……

3 यस्तो यात्रामा औसतमा कती दुरी पार गर्नुहुन्छ ? (in km)
……

4 यस्तो यात्रामा गाडीमा कति समय लाग्छ (मिनेट) ?
सामन्यतया .....
घटिमा .....
बढिमा .....

5 यस्तो यात्रामा कस्तो सवारी प्रयोग गर्नुहुन्छ ?
( ) निजी सवारी
( ) सार्वजनिक सवारी

6 निम्नलिखितमध्य कुन निजी सवारी प्रयोग गर्नुहुन्छ ? (निजी सवारीकोलागी मात्र)
( ) दुई-पाङ्ग्रे
( ) चार-पाङ्ग्रे

7 तपाईंले यात्रा गर्दा निम्नलिखितमध्य कुन लाई यात्रा खर्च मान्नुहुन्छ ? (निजी सवारीकोलागी मात्र)(एक भन्दा बढी बिकल्प छनौट गर्न मिल्ने)
[ ] ईन्धन खर्च (माइलेज)
[ ] सवारी मर्मतसम्भार तथा सर्भिसिङ्ग खर्च
[ ] वार्षिक नवीकरण कर
[ ] प्रती किमी औसत लगानी (सुरुमा सवारी किन्दा लागेको खर्च र अपेक्षित किमीको अनुपात)

8 तपाईंले एकतर्फी सो यात्रा गर्दा लाग्ने औसत गाडीभाडा? (सार्वजनिक सवारी)
……

9 तपाईंले गाडी भित्र गर्ने यात्राको समय घटाउनकालागि के तपाईं अतिरिक्त खर्च बेहोर्न इच्छुक हुनुहुन्छ ?
( ) छु
( ) छैन
( ) सायद

10 यात्राको समय बाहेक अन्य कुनै कुराकोलागी अतिरिक्त खर्च बेहोर्न इच्छुक हुनुहुन्छ ? (जस्तै:आरामदायी यात्रा, बिश्वासनिय यात्रा अथवा अरु कुनै) (एक भन्दा बढी बिकल्प छनौट गर्न मिल्ने)
[ ] आरामदायी यात्रा
[ ] भरपर्दो यात्रा (सधै एउटै यात्रा समय)
[ ] सुरक्षित यात्रा
[ ] अन्य भए लेख्नुहोस् .....

APPENDIX B: Questionnaire for Private Vehicle User

"यो प्रश्नावली ट्रान्सपोर्टेशन ईन्जिनियरिङ स्नातकोत्तर तहको थेसिसको लागि तयार पारिएको हो । यो प्रश्नवाली काठमाडौं उपत्यकामा यात्रा गर्नुहुने यात्रुहरुको लागि तयार परिएको हो । यसबाट आउने कुनैपनि व्यक्तिगत विवरणहरु कुनै पनि माध्यमबाट खुलासा हुनेछैनन् र अध्ययनका लागि मात्र प्रयोग गरिने छन् ।"

(This questionnaire is prepared for Master's thesis in Transportation Engineering. This questionnaire is for commuters in Kathmandu valley. Any personal details obtained will not be disclosed by any means and will be used for study purposes only)

SOCIOECONOMIC CHARACTERISTICS: Please tick (✓) the alternative that suits you

1. लिङ्ग (Gender)
    a. पुरुष (Male)
    b. महिला (Female)
2. वैवाहिक अवस्था (Marital Status)
    a. विवाहित (Married)
    b. अविवाहित (Unmarried)
3. तपाईको उमेर (वर्षमा) (Age in years)
    a. १५-२४ (15-24)
    b. २५-३४ (25-34)
    c. ३५-४४ (35-44)
    d. ४५-६० (45-60)
    e. ६० वा ६० भन्दा बढी (>60)
4. तपाईको परिवार सदस्य संख्या (Family size)
    a. ३ वा ३ भन्दा कम (<=3)
    b. ४ (4)
    c. ५ (5)
    d. ६ वो ६ भन्दा बढी (>=6)
5. परिवारमा आयआर्जन भएका सदस्य संख्या (Number of earning members in the family)
    a. १ (1)
    b. २ (2)
    c. ३ वा ३ भन्दा बढी (>=3)
6. रोजगारीको किसिम (Employment)
    a. व्यापार व्यवसाय (Business)

b. सरकारी जागिर (Government Job)

c. निजिक्षेत्रको जागिर (Private Job)

d. स्वरोजगार (Self-Employed)

e. विद्यार्थी (Student)

f. अवकाश प्राप्त (Retired)

g. रोजगारविहिन (Unemployed)

h. ……

7. परिवारको मासिक आम्दानी (ने रु) (Monthly income of family in NRs.)

   a. <१५००० (<15000)

   b. १५०००-३०००० (15000-30000)

   c. ३००००-४५००० (30000-45000)

   d. ४५०००-६०००० (45000-60000)

   e. ६००००-७५००० (60000-75000)

   f. ७५०००-९०००० (75000-90000)

   g. >९०००० (>90000)

8. सवारी साधन स्वामित्व (Vehicle Ownership)

   a. छ (Yes)

   b. छैन (No)

   c. कार्यालायले उपलब्ध गराएको (Provided by Office)

TRIP CHARACTERISTICS: Please tick (✓) the alternative that suits you

यस प्रश्नावलीमा एकतर्फी वा एकपटकको यात्राको आधारमा यात्रा समय, खर्च, दुरी आदि सोधिएका छन् । मानिलिऊ तपाईं घरबाट अफिस र अफिसबाट घर आउनुहुन्छ भने त्यसबखत तपाइंको यात्रा संख्या दुइ (वा दुइ एकतर्फी यात्रा) हुनेछ । यदी तपाईं दिनमा दुई पटक यात्रा गनुहुन्छ भने कुनै एक पटकको वा एकतर्फी यात्रालाई आधार बनाउनुहोला।

Please provide the details of any one trip that you make in a day. For example, if you travel from home to office and return back then the number of trips would be two. If you travel twice in a day then please mention details about any one trip in the following questions. Such a trip would comprise one-way trip

9. तपाईंको यात्राको माध्यम (Your Mode of Travel)

   a. दुई-पाङ्रे (Two-Wheeler) - निजी सावारी (Private Vehicle)

   b. चार-पाङ्रे (Four-Wheeler) - निजी सावारी (Private Vehicle)

10. आफ्नो सवारी सधान वा कार्यालयले उपलब्ध गरएको भए दुई-पाङ्रे सवारीको संख्या (Number of two-wheeler ownership)

a. ……

11. आफ्नो सवारी सधान वा कार्यालयले उपलब्ध गरएको भए दुई-पाङ्रे सवारीको संख्या (Number of two-wheeler ownership)
    a. ……
12. एक दिनमा कति पटक यात्रा गर्नुहुन्छ? मानिलिऊ तपाईं घरबाट अफिस र अफिसबाट घर आउनुहुन्छ भने त्यसबखत तपाइंको यात्रा संख्या दुइ हुनेछ ! ((Number of trips in a day; For example, if you travel from home to office and return back then the number of trips would be two)
    a. …….
13. तपाईंले यात्रा दिनको कुन समयमा गर्नुहुन्छ? यदी तपाईं दिनमा दुई पटक यात्रा गर्नुहुन्छ भने कुनै एक पटकको यात्राको बारेमा लेखिदिनुहोला । When do you travel ? If you travel twice in a day then please mention about any one trip
    a. बिहान ८ बजेभन्दा पहिला (Before 8 AM)
    b. बिहानको ८ - ११ बजे (8 AM - 11 AM)
    c. बिहानको ११ - दिउँसोको ४ बजे (11 AM - 4 PM)
    d. दिउँसोको ४ - बेलुका ७ बजे (4 PM - 7 PM)
    e. बेलुका ७ बजे भन्दा पछाडी (After 7 PM)
14. तपाईंको यात्राको उद्धेश्य (Your Purpose of Trip) जुन एकतर्फी यात्राको लागी समय लेख्नुभएको हो, त्यही यात्राको उद्धेश्य (Purpose of one-way trip that you denoted while mentioning time)
    a. कामकाज / जागिर (Work)
    b. व्यापार (Business)
    c. अध्ययन (Study)
    d. मनोरन्जन / सामाजिक / पारिवरिक (Recreational / Social Activity)
    e. …….
15. माथि उल्लिखित एकतर्फी वा एकपटकको यात्राको यात्रा दुरी । (Trip Distance of aforementioned one-way trip) कि.मि. (in km)
    a. ……..
16. माथि उल्लिखित एकतर्फी वा एकपटकको यात्राको यात्रा खर्च (Cost of Travel of aforementioned trip) NRs.
    a. …….
17. माथि उल्लिखित एकतर्फी वा एकपटकको यात्रागर्दा सावारी साधनमा लाग्ने समय (In-Vehicle Travel Time for aforementioned one-way trip trip) मिनेट (Minutes)
    a. ……..
18. तपाईंको यात्राको अनुभवको आधारमा निम्न मध्य कुन ठीक हो ? Which of the following is true based on your experience?
    a. सधै जसो एकै समयमा पुगिन्छ (Travel Time is consistent)

b. यकिनले केहि भन्न सकिन्न (Travel Time is inconsistent)

यात्रा खर्च, सवारी साधानमा लाग्ने यात्रा समय र यात्रा समयको विश्वसनीयताका आधारमा तपाईंलाई निम्नलिखित चार अवस्थाहरु प्रस्तुत गरिएका छन् । (You are presented with following conditions where trip cost, travel time and travel time reliability are different compared to current scenario) हरेक प्रश्नका लागि उपयुक्त विकल्पहरु छनाैट गर्नुहाेस् । (please make your choices)

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 1	Reduced by 40% यात्रा समय अहिलेको भन्दा ४०% कम	Increased by 40% अहिलेको भन्दा ४०% बढी	Reliable सधै समयमै पुगिन्छ	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 2	Reduced by 20% यात्रा समय अहिलेको भन्दा २०% कम	Increased by 40% यात्रा खर्च अहिलेको भन्दा ४०% बढी	Reliable सधै समयमै पुगिन्छ	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 3	Reduced by 20% यात्रा समय अहिलेको भन्दा २०%	Increased by 20% यात्रा समय अहिलेको भन्दा २०% बढी	Non-reliable सधै समयमा पुगिन्छ भनेर यकिनले भन्न सकिन्न	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 4	Reduced by 40% यात्रा समय अहिलेको भन्दा ४०% कम	Increased by 45% यात्रा समय अहिलेको भन्दा २०% बढी	Non-reliable सधै समयमा पुगिन्छ भनेर यकिनले भन्न सकिन्न	

APPENDIX C: Questionnaire for Public Vehicle User

"यो प्रश्नावली ट्रान्सपोर्टेशन ईन्जिनियरिङ स्नातकोत्तर तहको थेसिसको लागि तयार पारिएको हो । यो प्रश्नवाली काठमाडौं उपत्यकामा यात्रा गर्नुहुने यात्रुहरुको लागि तयार परिएको हो । यसबाट आउने कुनैपनि व्यक्तिगत विवरणहरु कुनै पनि माध्यमबाट खुलासा हुनेछैनन् र अध्ययनका लागि मात्र प्रयोग गरिने छन् ।"

(This questionnaire is prepared for Master's thesis in Transportation Engineering. This questionnaire is for commuters in Kathmandu valley. Any personal details obtained will not be disclosed by any means and will be used for study purposes only)

SOCIOECONOMIC CHARACTERISTICS: Please tick (✓) the alternative that suits you

1. लिङ्ग (Gender)
    a. पुरुष (Male)
    b. महिला (Female)
2. वैवाहिक अवस्था (Marital Status)
    a. विवाहित (Married)
    b. अविवाहित (Unmarried)
3. तपाईंको उमेर (वर्षमा) (Age in years)
    a. १५-२४ (15-24)
    b. २५-३४ (25-34)
    c. ३५-४४ (35-44)
    d. ४५-६० (45-60)
    e. ६० वा ६० भन्दा बढी (>60)
4. तपाईंको परिवार सदस्य संख्या (Family size)
    a. ३ वा ३ भन्दा कम (<=3)
    b. ४ (4)
    c. ५ (5)
    d. ६ वो ६ भन्दा बढी (>=6)
5. परिवारमा आयआर्जन भएका सदस्य संख्या (Number of earning members in the family)
    a. १ (1)
    b. २ (2)
    c. ३ वा ३ भन्दा बढी (>=3)
6. रोजगारीको किसिम (Employment)
    a. व्यापार व्यवसाय (Business)

b. सरकारी जागिर (Government Job)

c. निजिक्षेत्रको जागिर (Private Job)

d. स्वरोजगार (Self-Employed)

e. विद्यार्थी (Student)

f. अवकाश प्राप्त (Retired)

g. रोजगारविहिन (Unemployed)

h. ……

7. परिवारको मासिक आम्दानी (ने रु) (Monthly income of family in NRs.)

a. <१५००० (<15000)

b. १५०००-३०००० (15000-30000)

c. ३००००-४५००० (30000-45000)

d. ४५०००-६०००० (45000-60000)

e. ६००००-७५००० (60000-75000)

f. ७५०००-९०००० (75000-90000)

g. >९०००० (>90000)

8. सवारी साधन स्वामित्व (Vehicle Ownership)

a. छ (Yes)

b. छैन (No)

c. कार्यालायले उपलब्ध गराएको (Provided by Office)

TRIP CHARACTERISTICS: Please tick (✓) the alternative that suits you

यस प्रश्नावलीमा एकतर्फी वा एकपटकको यात्राको आधारमा यात्रा समय, खर्च, दुरी आदि सोधिएका छन् । मानिलिऊ तपाईं घरबाट अफिस र अफिसबाट घर आउनुहुन्छ भने त्यसबखत तपाइंको यात्रा संख्या दुइ (वा दुइ एकतर्फी यात्रा) हुनेछ । यदी तपाईं दिनमा दुई पटक यात्रा गनुहुन्छ भने कुनै एक पटकको वा एकतर्फी यात्रालाई आधार बनाउनुहोला।

Please provide the details of any one trip that you make in a day. For example, if you travel from home to office and return back then the number of trips would be two. If you travel twice in a day then please mention details about any one trip in the following questions. Such a trip would comprise one-way trip

9. तपाईंको यात्राको माध्यम (Your Mode of Travel)

a. बस (Bus) - सार्वजनिक सावारी साधन (Public Transport)

b. माईक्रो बस (Micro Bus) - सार्वजनिक सावारी साधन (Public Transport)

c. टेम्पो (Tempo) - सार्वजनिक सावारी साधन (Public Transport)

10. एक दिनमा कति पटक यात्रा गर्नुहुन्छ? मानिलिऊ तपाईं घरबाट अफिस र अफिसबाट घर आउनुहुन्छ भने त्यसबखत तपाइंको यात्रा संख्या दुइ हुनेछ ! ((Number of trips in a day; For example, if you travel from home to office and return back then the number of trips would be two)
    a. …….
11. तपाईंले यात्रा दिनको कुन समयमा गर्नुहुन्छ? यदी तपाईं दिनमा दुई पटक यात्रा गर्नुहुन्छ भने कुनै एक पटकको यात्राको बारेमा लेखिदिनुहोला । When do you travel ? If you travel twice in a day then please mention about any one trip
    a. बिहान ८ बजेभन्दा पहिला (Before 8 AM)
    b. बिहानको ८ - ११ बजे (8 AM - 11 AM)
    c. बिहानको ११ - दिउँसोको ४ बजे (11 AM - 4 PM)
    d. दिउँसोको ४ - बेलुका ७ बजे (4 PM - 7 PM)
    e. बेलुका ७ बजे भन्दा पछाडी (After 7 PM)
12. तपाईंको यात्राको उद्धेश्य (Your Purpose of Trip) जुन एकतर्फी यात्राको लागी समय लेख्नुभएको हो, त्यही यात्राको उद्धेश्य (Purpose of one-way trip that you denoted while mentioning time)
    a. कामकाज / जागिर (Work)
    b. व्यापार (Business)
    c. अध्ययन (Study)
    d. मनोरन्जन / सामाजिक / पारिवरिक (Recreational / Social Activity)
    e. …….
13. माथि उल्लिखित एकतर्फी वा एकपटकको यात्राको यात्रा दुरी । (Trip Distance of aforementioned one-way trip) कि.मि. (in km)
    a. ……..
14. माथि उल्लिखित एकतर्फी वा एकपटकको यात्राको यात्रा भाडा (Cost of Travel of aforementioned one-way trip) ने रु (NRs.)
    a. ……
15. माथि उल्लिखित एकतर्फी वा एकपटकको यात्रागर्दा स्टेसनसम्म पुग्न लाग्ने समय (Time to reach station for aforementioned one-way trip) मिनेट (Minutes)
    a. …….
16. माथि उल्लिखित एकतर्फी वा एकपटकको यात्रागर्दा गाडीलाई पर्खने समय (Vehicle waiting Time for aforementioned one-way trip) मिनेट (Minutes)
    a. …….
17. माथि उल्लिखित एकतर्फी वा एकपटकको यात्रागर्दा सावारी साधनमा लाग्ने समय (In-Vehicle Travel Time for aforementioned one-way trip) मिनेट (Minutes)
    a. …….

18. माथि उल्लिखित एकतर्फी वा एकपटकको यात्राको यात्रा खर्च (Cost of Travel of aforementioned trip) NRs.
    a. …….
19. तपाईको सो एकतर्फी वा एकपटकको यात्रा गरिसकेपछी स्टेसनबाट गन्तव्यसम्म लाग्ने समय (Time to reach destination from station for aforementioned one-way trip) मिनेट (Minutes)
    a. …….
20. माथि उल्लिखित एकतर्फी वा एकपटकको यात्रागर्दा सावारी साधनमा लाग्ने समय (In-Vehicle Travel Time for aforementioned one-way trip trip) मिनेट (Minutes)
    a. ……..
21. तपाईको यात्राको अनुभवको आधारमा निम्न मध्य कुन ठीक हो ? Which of the following is true based on your experience?
    a. सधै जसो एकै समयमा पुगिन्छ (Travel Time is consistent)
    b. यकिनले केहि भन्न सकिन्न (Travel Time is inconsistent)

यात्रा खर्च, सवारी साधानमा लाग्ने यात्रा समय र यात्रा समयको विश्वसनीयताका आधारमा तपाईंलाई निम्नलिखित चार अवस्थाहरु प्रस्तुत गरिएका छन् । (You are presented with following conditions where trip cost, travel time and travel time reliability are different compared to current scenario) हरेक प्रश्नका लागि उपयुक्त विकल्पहरु छनाैट गर्नुहाेस् । (please make your choices)

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 1	Reduced by 50% यात्रा समय अहिलेको भन्दा ५०% कम	Increased by 50% यात्रा खर्च अहिलेको भन्दा ५०% बढी	Reliable सधै समयमै पुगिन्छ	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 2	Reduced by 25% यात्रा समय अहिलेको भन्दा २५% कम	Increased by 50% यात्रा खर्च अहिलेको भन्दा ५०% बढी	Reliable सधै समयमै पुगिन्छ	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 3	Reduced by 25% यात्रा समय अहिलेको भन्दा २५% कम	Increased by 25% यात्रा खर्च अहिलेको भन्दा २५% बढी	Non-reliable सधै समयमा पुगिन्छ भनेर यकिनले भन्न सकिन्न	

Attribute	In-Vehicle Travel Time	Travel Cost	Reliability	Choice
Presently Used mode	अहिलेको यात्रा समय, यात्रा खर्च र विस्वसनियता नै ठीक छ			
Alternative 4	Reduced by 50% यात्रा समय अहिलेको भन्दा ५०% कम	Increased by 25% यात्रा खर्च अहिलेको भन्दा २५% बढी	Non-reliable सधै समयमा पुगिन्छ भनेर यकिनले भन्न सकिन्न	

APPENDIX D: VTT in US$

Exchange Rates adopted:

	Currency	Exchange Rate (1 US$)	Year (AD)	Source
(Fezzi, et al., 2014)	€	0.7511	2010	web*
		0.719	2011	
(Athira, et al., 2016)	INR	60.999	2014	web*
(Bajracharya, 2017)	NPR	103	2017	literature
(Transport for Rural Development, 2002)	Taka	58.824	2001	literature
(Joshi & Acharya, 2019)	NPR	112.574	2019	web*
(Ghimire & Marsani, 2019)	NPR	112.574	2019	web*
(MRCU-MAINTENANCE REHABILITATION CO-ORDINATION, 2001)	NPR	70	2001	literature
(Shrestha, 2019) ; TPPF - 2014	NPR	97.764	2014	web*
(ADB, 2017)	NPR	102.65	2017	literature

VTT

	VTT (per hour)	VTT in U$ per hour
Fezzi et. al. (2014)	€ 8.4 to €9.4	11.43 to 12.79
Athira, et al., (2016)	Rs. 35.73 to 142.19	0.586 to 2.33
Transport for Rural Development, (2002)	3.5 tk (in-vehicle) 3.91 (walking)	0.0595 (in-vehicle) 0.0665 (walking)
(Bajracharya, 2017)	Rs. 25.11 to 180	0.243 to 1.747
Joshi and Acharya (2019)	Rs 95	0.844
Ghimire and Marsani (2019)	Rs. 46.27 (two-wheeler) Rs. 55.8 (four-wheeler)	0.411 (two-wheeler) 0.495 (four-wheeler)
(MRCU-MAINTENANCE REHABILITATION CO-ORDINATION, 2001)	Rs 5.3	0.0757

	(ADB, 2017)			
	Passenger work time		**Passenger non-work time**	
	(Rs. per hour)	(US$ per hour)	(Rs. per hour)	(US$ per hour)
Motorcycle	108	1.052	27	0.263
Car/4W	180	1.754	45	0.438
Bus	83	0.809	21	0.205

	(Shrestha, 2019) based on TPPF-2014			
	Passenger work time		Passenger non-work time	
	(Rs. per hour)	(US$ per hour)	(Rs. per hour)	(US$ per hour)
Motorcycle	72	0.736	21	0.215
Car/4W	95	0.972	29	0.297
Bus	62	0.634	19	0.194
Minibus	72	0.736	21	0.215
Microbus	72	0.736	21	0.215
Three-wheeler	62	0.634	19	0.194

* web source - https://www.exchangerates.org.uk/

[1 US$= NRs. 119.4, August 2020]

APPENDIX E: Coding in R

```
library(car)  #attaching library car
a<-Import("Data.xlsx") #importing data to variable a
a$Income<-as.factor(a$Income) # Converting to factor
#inserting randomness in age
for (i in 1:nrow(a)){
  if (a$Age[i]== 1 ){
    set.seed(123+i)
    a$Age[i]<- sample(15:25,1)
  } else if (a$Age[i]== 2 ){
    set.seed(234+i)
    a$Age[i] <- sample(24:36,1)
  }else if (a$Age[i]== 3 ){
    set.seed(345+i)
    a$Age[i] <- sample(35:46,1)
  }else if (a$Age[i]== 4 ){
    set.seed(456+i)
    a$Age[i] <- sample(45:59,1)
  }else if (a$Age[i]== 5 ){
    set.seed(567+i)
    a$Age[i] <- sample(60:70,1)
  }}
b<-a #assigning a to b
#removing unnecessary items
b<-b[,c(-1,-17,-18,-19,-20,-21,-22,-23,-24,-25,-26,-28,-29,-30)]

#multinomial logit modelling for RP data
library(VGAM)
mod.glm <- vglm(formula =Mode ~ Cost+Reliability+T_Time, family = multinomial
                (zero = NULL, parallel = FALSE,refLevel = "Public", whitespace = FALSE),
                data = a)
null.glm <- vglm(formula = Mode ~ 1, family = multinomial
                 (zero = NULL, parallel = FALSE,refLevel = "Public", whitespace = FALSE),
                 data = a)
summary(mod.glm)
pseudoR2<- 1-deviance(mod.glm)/deviance(null.glm)
#unloading VGAM package as it interferes with tests in mlogit package
detach("package:VGAM", unload=TRUE)

#formatting data in wide format for use in mlogit package
id<-1
choiceid<-1
```

```
choice<-"A"
price_A<-0
reliability_A<-0
time_A<-0
price_B<-0
reliability_B<-0
time_B<-0
final<-b[1,]
final<-
cbind(id,choiceid,final,choice,price_A,reliability_A,time_A,price_B,reliability_B,time_B)
for (i in 1:nrow(b))
{
 for (j in 1:4)
 {
  te<-b[i,]
  t<-a[i,]
  id<-i
  choiceid<-j
  if (t[22+j] == "Current")
  {
   choice = "A"
  }
  else
  {
   choice="B"
  }
  price_A<-t$Cost
  time_A<-t$In_Time
  if (t$Reliability == "Consistent")
  {
   reliability_A<-0
  }
  else
  {
   reliability_A<-1
  }
  if (t$Mode == "Private")
  {
   if (j == 1)
   {
    price_B<-price_A*1.4
    time_B<-time_A*.6
    reliability_B<-1
```

```
  }
  if (j == 2)
  {
    price_B<-price_A*1.4
    time_B<-time_A*.8
    reliability_B<-1
  }
  if (j == 3)
  {
    price_B<-price_A*1.2
    time_B<-time_A*.8
    reliability_B<-0
  }
  if (j == 4)
  {
    price_B<-price_A*1.2
    time_B<-time_A*.6
    reliability_B<-0
  }
}
if (t$Mode == "Public")
{
  if (j == 1)
  {
    price_B<-price_A*1.5
    time_B<-time_A*.5
    reliability_B<-1
  }
  if (j == 2)
  {
    price_B<-price_A*1.5
    time_B<-time_A*0.75
    reliability_B<-1
  }
  if (j == 3)
  {
    price_B<-price_A*1.25
    time_B<-time_A*0.75
    reliability_B<-0
  }
  if (j == 4)
  {
    price_B<-price_A*1.25
```

```
      time_B<-time_A*.5
      reliability_B<-0
    }
  }

  te <-
cbind(id,choiceid,te,choice,price_A,reliability_A,time_A,price_B,reliability_B,time_B)
  final<-rbind(final,te)
 }
}
final<-final[-1,]
#removing unused variables
rm(t,te,choice,choiceid,i,id,j,price_A,price_B,reliability_A,reliability_B, time_A, time_B)

#The following code is for work trips using public vehicles
finally<-final[final$Mode %in% "Public",]
finally<-finally[finally$Purpose %in% "Work",]
#Converting in long format
Analysis<- mlogit.data(finally, shape = "wide", choice = "choice",
                       varying = 20:25, sep="_", id.var = "id",
                       opposite = c("price", "time", "reliability"))
# "Analysis" variable is used for analysis purpose
Analysis$time<-Analysis$time/60  #Converting minute to hour

#Estimating Multinomial logit model
SP.ml <- mlogit(choice ~ price + time + reliability  | - 1, Analysis)
summary(SP.ml)
coef(SP.ml)[-1]/coef(SP.ml)[1] #Dividing by price coefficient

#Estimating non-correlated mixed logit model with time and reliability as random with
normal distribution
SP.mxlu <- mlogit(choice ~ price + time + reliability |-1, Analysis,
                  panel = TRUE, rpar = c(time = "n", reliability="n"), R = 100,
                  correlation = FALSE, halton = NA, method = "bhhh")
summary(SP.mxlu)
coef(SP.mxlu)[-1]/coef(SP.mxlu)[1] #Dividing by price coefficient
#Estimating correlated mixed logit model
SP.mxlc <- update(SP.mxlu, correlation = TRUE)
summary(SP.mxlc)
coef(SP.mxlc)[-1]/coef(SP.mxlc)[1] #Dividing by price coefficient

#Defining function to calculate p-value used for different tests like score-test, wald test, etc.
statpval <- function(x){
```

```
  if (inherits(x, "anova"))
    result <- as.matrix(x)[2, c("Chisq", "Pr(>Chisq)")]
  if (inherits(x, "htest")) result <- c(x$statistic, x$p.value)
  names(result) <- c("stat", "p-value")
  round(result, 3)
}

#Performing different tests including tests of no correlated random effects:
lr.mxc <- lrtest(SP.mxlc, SP.ml) #Likelihood ratio test
wd.mxc <- waldtest(SP.mxlc)  #Wald test to check significance of explanatory variables
lh.mxc <- linearHypothesis(SP.mxlc, c("chol.time:time = 0",
                                      "chol.time:reliability =0",
                                      "chol.reliability:reliability=0")) #Linear hypothesis test
#Score test
sc.mxc <- scoretest(SP.ml, rpar = c(time = "n", reliability = "n"),
                    R = 100, correlation = TRUE, halton = NA, panel = TRUE)
sapply(list(wald = wd.mxc, lh = lh.mxc, score = sc.mxc, lr = lr.mxc),
       statpval)

#Performing different tests including tests for correlation:
lr.corr <- lrtest(SP.mxlc, SP.mxlu)
wd.corr <- waldtest(SP.mxlc, correlation=FALSE)
lh.corr <- linearHypothesis(SP.mxlc, c("chol.time:reliability =0"))
sc.corr <- scoretest(SP.mxlu, correlation = TRUE)
sapply(list(wald = wd.corr, lh = lh.corr, score = sc.corr, lr = lr.corr),
       statpval)
```

APPENDIX F: Sample of Collected data of Perception Survey

Number_of_trip	Purpose_G	Distance	Time_Avg	Time_Min	Time_Max	Mode	Pri_Cost	Pub_Cost	WTP	Other
2	Business	5	15	10	25	Private	Mileage	20	Maybe	Comfort, Reilability, Safety, None
2	Business	3.5	8	3	15	Private	Mileage, OM		Maybe	Comfort, Safety
2	Business	1	7	5	10	Public		15	Maybe	Comfort, Reilability, Safety
4	Business	30	60	60	90	Private	Mileage, OM, Tax		No	Safety
2	Business	2	10	5	15	Public		15	No	Reilability
2	Business	10	30	25	35	Private	Mileage		Yes	Comfort
2	Business	5	15	10	20	Private	Mileage		Yes	Comfort, Safety
4	Business	20	30	25	35	Private	Mileage		Yes	Comfort, Safety
2	Business	6	20	15	30	Private	Mileage		Yes	
2	Business	50	60	30	90	Private	Tax		Yes	Comfort
5	Business	60	120	130	180	Private	Mileage, OM	500	Yes	Comfort, Safety
4	Business	15	60	45	75	Private	Mileage, OM, Tax, Initial_Investment		Yes	Reilability, Safety
2	Business	10	90	60	120	Public		10	Yes	Comfort, Reilability, Safety
4	Business	16	60	45	120	Public		20	Yes	Comfort, Reilability, Safety
2	Business	20	45	30	75	Public		25	Yes	Comfort, Reilability, Safety
3	Business	20	60	50	70	Public		45	Yes	Comfort, Reilability, Safety
40	Business	40	70	70	100	Private	Mileage, OM, Tax, Initial_Investment	200	No	Safety
6	Other	25	15	10	30	Private	Tax	150	Yes	None
2	Work	17	45	13	60	Private	Mileage, OM, Tax		Yes	Reilability

APPENDIX G: Sample of Collected data of RP/SP survey

Gender	Marital_Status	Age	Family_Size	Earner	Employment	Income	Veh_Owner	Mode	Two_Wheeler	Four_Wheeler	Number_of_Trips	Specific_Mode	Purpose	Distance	Cost	To_Station	Waiting	In_Time	From_Station	Reliability	Alt_1	Alt_2	Alt_3	Alt_4	Time_of_day
Male	Married	2	5	2	Private_Job	4	Yes	Private	3	0	6	Two-Wheeler	Work	3	20	0	0	6	0	Consistent	Current	Current	Current	Current	Before 8am
Male	Unmarried	2	4	2	Private_Job	3	Yes	Private	2	0	3	Two-Wheeler	Work	5	30	0	0	10	0	Inconsistent	Alternative1	Alternative2	Alternative3	Current	8am to 11am
Male	Unmarried	2	5	3	Private_Job	7	Yes	Private	2	0	2	Two-Wheeler	Work	6	100	0	0	20	0	Consistent	Current	Current	Alternative3	Current	8am to 11am
Male	Married	4	3	1	Government_Job	3	Yes	Private	1	0	4	Two-Wheeler	Work	3	20	0	0	10	0	Consistent	Alternative1	Alternative2	Current	Current	8am to 11am
Male	Unmarried	2	5	3	Private_Job	7	Yes	Private	1	0	2	Two-Wheeler	Work	4	15	0	0	8	0	Consistent	Current	Current	Current	Current	8am to 11am
Male	Married	3	6	2	Self_Employed	4	Yes	Private	2	1	2	Two-Wheeler	Work	2	30	0	0	15	0	Inconsistent	Current	Current	Current	Current	8am to 11am
Male	Unmarried	3	5	3	Private_Job	5	Provided_by_Office	Private	1	0	3	Two-Wheeler	Work	6	50	0	0	20	0	Consistent	Current	Current	Current	Current	4pm to 7pm
Male	Unmarried	1	5	1	Private_Job	4	Yes	Private	2	0	2	Two-Wheeler	Study	10	40	0	0	30	0	Consistent	Current	Current	Current	Current	Before 8am
Male	Unmarried	2	4	3	Private_Job	7	Yes	Private	1	1	2	Two-Wheeler	Work	12	100	0	0	30	0	Consistent	Current	Current	Current	Alternative4	8am to 11am
Male	Unmarried	2	4	3	Private_Job	7	Yes	Private	1	1	2	Two-Wheeler	Work	12	100	0	0	30	0	Consistent	Current	Current	Current	Alternative4	8am to 11am
Male	Married	2	6	3	Business	7	Yes	Private	1	0	2	Two-Wheeler	Work	20	100	0	0	55	0	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	6	2	Business	7	Yes	Private	2	2	2	Two-Wheeler	Study	10	55	0	0	20	0	Consistent	Current	Current	Current	Current	Before 8am
Male	Unmarried	1	5	1	Government_Job	3	Yes	Private	1	0	4	Two-Wheeler	Study	12	160	0	0	30	0	Inconsistent	Current	Current	Alternative3	Alternative4	Before 8am
Male	Married	3	4	1	Government_Job	6	Yes	Private	1	0	4	Two-Wheeler	Work	4	30	0	0	20	0	Consistent	Current	Alternative2	Alternative3	Alternative4	Before 8am
Male	Unmarried	2	6	3	Government_Job	6	Provided_by_Office	Private	2	0	2	Two-Wheeler	Work	18	45	0	0	75	0	Consistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	3	2	Private_Job	3	Yes	Private	1	0	1	Two-Wheeler	Work	15	50	0	0	30	0	Inconsistent	Current	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	5	3	Private_Job	7	Yes	Private	2	0	2	Two-Wheeler	Work	13	100	0	0	30	0	Inconsistent	Current	Current	Current	Current	8am to 11am
Male	Married	2	5	2	Private_Job	5	Yes	Private	1	0	2	Two-Wheeler	Work	9	20	0	0	20	0	Inconsistent	Current	Current	Alternative3	Alternative4	8am to 11am

Male	Unmarried	1	4	3	Government_Job	7	Yes	Private	1	1	2	Two-Wheeler	Work	10	100	0	0	25	0	Inconsistent	Current	Current	Current	Current	8am to 11am
Male	Married	2	5	3	Private_Job	3	Yes	Private	1	1	2	Two-Wheeler	Work	15	50	0	0	45	0	Consistent	Current	Current	Current	Current	8am to 11am
Male	Unmarried	2	6	2	Government_Job	6	Yes	Private	1	0	2	Two-Wheeler	Work	20	100	0	0	30	0	Consistent	Alternative1	Current	Current	Current	8am to 11am
Male	Married	2	6	3	Self_Employed	7	Yes	Private	1	1	2	Four-Wheeler	Work	15	150	0	0	60	0	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Female	Unmarried	1	4	1	Business	4	Yes	Private	1	1	2	Two-Wheeler	Study	7	40	0	0	40	0	Inconsistent	Current	Current	Alternative3	Alternative4	Before 8am
Male	Unmarried	2	3	3	Private_Job	7	Yes	Private	2	0	2	Two-Wheeler	Work	7	13	0	0	30	0	Consistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	5	3	Government_Job	6	No	Private	0	1	2	Four-Wheeler	Work	12	100	0	0	30	0	Inconsistent	Current	Current	Current	Alternative4	8am to 11am
Female	Unmarried	1	4	2	Student	1	Yes	Private	1	0	4	Two-Wheeler	Study	10	60	0	0	1	0	Inconsistent	Alternative1	Current	Alternative3	Alternative4	Before 8am
Male	Unmarried	2	4	3	Government_Job	3	Yes	Private	1	0	2	Two-Wheeler	Work	2	50	0	0	15	0	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	4	3	Private_Job	5	Yes	Private	1	0	2	Two-Wheeler	Work	25	50	0	0	40	0	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	Before 8am
Male	Married	2	6	3	Private_Job	7	Yes	Private	3	2	2	Two-Wheeler	Work	5	15	0	0	15	0	Consistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Married	2	3	2	Business	4	Yes	Private	1	0	2	Two-Wheeler	Study	10	200	0	0	30	0	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	4pm to 7pm
Male	Married	2	4	2	Business	3	Yes	Private	1	0	2	Two-Wheeler	Work	7	25	0	0	30	0	Inconsistent	Alternative1	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	6	2	Private_Job	3	Yes	Private	1	0	2	Two-Wheeler	Work	6.7	40	0	0	30	0	Inconsistent	Current	Current	Current	Alternative4	8am to 11am
Female	Unmarried	1	6	3	Business	3	Yes	Private	1	0	4	Two-Wheeler	W/S	14	150	0	0	15	0	Inconsistent	Current	Current	Current	Alternative4	8am to 11am
Male	Married	2	6	2	Private_Job	3	Yes	Private	1	0	15	Two-Wheeler	Work	15	150	0	0	20	0	Consistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	3	1	Private_Job	3	Yes	Private	1	0	2	Two-Wheeler	Work	1.5	30	0	0	5	0	Consistent	Current	Current	Current	Current	8am to 11am
Female	Unmarried	1	5	1	Government_Job	3	Provided_by_Office	Private	1	1	2	Two-Wheeler	Work	10	100	0	0	25	0	Consistent	Alternative1	Alternative2	Current	Current	8am to 11am
Male	Unmarried	1	4	3	Private_Job	7	Yes	Private	1	0	2	Two-Wheeler	Work	5	28	0	0	15	0	Consistent	Current	Current	Current	Current	8am to 11am

Male	Unmarried	1	4	2	Government_Job	6	Provided_by_Office	Private	1	0	2	Two-Wheeler	Work	15	100	0	0	45	0	Inconsistent	Current	Alternative2	Alternative3	Alternative4	8am to 11am
Female	Unmarried	1	4	2	Student	3	Yes	Public			2	Micro	Study	2.5	10	10	1	5	30	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	Before 8am
Male	Unmarried	2	5	3	Government_Job	6	No	Public			1	Micro	Work	20	30	10	15	50	2	Inconsistent	Alternative1	Current	Current	Alternative4	8am to 11am
Male	Unmarried	1	4	1	Government_Job	4	No	Public			4	Bus	Study	5	10	20	10	20	20	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	Before 8am
Male	Unmarried	1	4	2	Student	4	No	Public			2	Bus	Study	3.8	10	10	2	5	12	Consistent	Current	Current	Current	Current	Before 8am
Male	Unmarried	1	4	2	Student	2	No	Public			2	Tempo	Study	5	15	12	5	15	6	Inconsistent	Current	Current	Current	Alternative4	Before 8am
Female	Unmarried	1	6	3	Government_Job	3	Yes	Public			2	Tempo	Study	4.5	18	12	5	15	10	Inconsistent	Current	Alternative2	Current	Alternative4	Before 8am
Female	Unmarried	1	4	1	Student		Yes	Public			1	Tempo	Recreation_Social	5	60	20	5	20	20	Inconsistent	Current	Current	Alternative3	Alternative4	4pm to 7pm
Female	Unmarried	2	5	3	Private_Job	3	Yes	Public			2	Bus	Work	12	20	30	20	12	15	Inconsistent	Current	Current	Current	Current	8am to 11am
Male	Married	2	3	2	Private_Job	7	No	Public			5	Micro	Work	20	35	60	10	60	0	Inconsistent	Current	Current	Current	Current	8am to 11am
Female	Unmarried	2	5	2	Private_Job	2	No	Public			2	Bus	Work	12	25	2	10	70	2	Consistent	Alternative1	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	5	1	Private_Job	1	No	Public			2	Bus	Study	3	20	20	5	25	25	Inconsistent	Current	Current	Current	Alternative4	Before 8am
Male	Married	4	5	2	Self_Employed	7	Provided_by_Office	Public			4	Bus	Work	9	15	10	3	10	5	Inconsistent	Alternative1	Current	Current	Alternative4	Before 8am
Female	Unmarried	2	4	3	Private_Job	5	No	Public			2	Micro	Recreation_Social	10	15	30	5	30	10	Inconsistent	Current	Current	Current	Current	4pm to 7pm
Female	Unmarried	1	4	2	Self_Employed	2	No	Public			1	Bus	Study	8	15	5	15	50	10	Inconsistent	Current	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	4	3	Student	4	Yes	Public			2	Bus	Study	8	30	45	5	20	30	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	5	1	Private_Job	2	Yes	Public			2	Bus	Study	3	20	20	10	20	5	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am

Male	Unmarried	2	5	2	Unemployed	6	No	Public			2	Tempo	Study	5	20	20	5	0	23	Consistent	Current	Current	Current	Current	Before 8am
Male	Unmarried	1	4	2	Private_Job	4	No	Public			2	Tempo	Work	7	20	5	10	35	10	Consistent	Current	Current	Current	Alternative4	8am to 11am
Male	Unmarried	1	4	3	Government_Job	6	No	Public			2	Bus	Work	7	30	15	5	5	5	Consistent	Current	Current	Current	Current	8am to 11am
Female	Unmarried	2	6	2	Government_Job	5	Yes	Public			2	Bus	Work	2	25	10	15	30	5	Inconsistent	Alternative1	Alternative2	Current	Alternative4	Before 8am
Female	Unmarried	1	6	3	Student	4	No	Public			2	Bus	Study	5	10	5	10	15	10	Consistent	Alternative1	Current	Alternative3	Alternative4	Before 8am
Male	Unmarried	1	4	3	Private_Job	7	No	Public			2	Micro	Work	4	15	15	5	15	15	Inconsistent	Current	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	2	4	3	Private_Job	6	Yes	Public			2	Micro	Work	4	20	10	5	15	20	Inconsistent	Current	Current	Current	Current	8am to 11am
Female	Unmarried	1	6	3	Private_Job	7	Provided_by_Office	Public			4	Micro	Work	9	25	70	20	40	50	Inconsistent	Alternative1	Current	Alternative3	Alternative4	8am to 11am
Male	Married	3	6	1	Government_Job	4	Yes	Public			2	Bus	Work	6	40	30	15	30	3	Inconsistent	Current	Current	Current	Current	11am to 4pm
Male	Married	2	5	2	Government_Job	4	Yes	Public			2	Tempo	Work	6	20	5	10	30	3	Inconsistent	Current	Current	Current	Current	8am to 11am
Female	Married	3	3	2	Government_Job	3	No	Public			2	Bus	Work	8	40	5	15	95	5	Inconsistent	Alternative1	Current	Current	Current	8am to 11am
Female	Married	2	3	1	Government_Job	3	No	Public			2	Bus	Work	4	15	10	15	30	5	Inconsistent	Current	Alternative2	Current	Alternative4	8am to 11am
Male	Married	3	4	1	Government_Job	4	No	Public			2	Bus	Work	6	20	5	5	50	5	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Female	Married	2	3	1	Government_Job	2	No	Public			2	Micro	Work	12	40	10	15	90	10	Inconsistent	Alternative1	Alternative2	Current	Alternative4	Before 8am
Male	Unmarried	1	6	1	Government_Job	4	No	Public			2	Bus	Study	4	15	25	5	25	25	Inconsistent	Current	Current	Current	Current	8am to 11am
Female	Married	2	5	2	Government_Job	7	No	Public			2	Micro	Work	10	25	15	10	25	15	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	5	2	Student	3	No	Public			2	Bus	Study	5	10	10	15	30	5	Inconsistent	Alternative1	Alternative2	Current	Current	8am to 11am

Male	Unmarried	1	4	1	Government_Job	3	Yes	Public			2	Bus	Study	10	10	5	5	30	5	Inconsistent	Alternative1	Alternative2	Current	Current	8am to 11am
Male	Unmarried	2	6	3	Business	2	No	Public			1	Tempo	Work	12	18	5	10	25	25	Inconsistent	Current	Current	Current	Alternative4	8am to 11am
Male	Unmarried	1	6	2	Unemployed	4	Yes	Public			3	Bus	Study	9	20	15	5	45	2	Consistent	Alternative1	Alternative2	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	4	2	Student	2	Yes	Public			4	Bus	Study	8	20	5	5	35	15	Inconsistent	Alternative1	Alternative2	Alternative3	Alternative4	Before 8am
Female	Unmarried	1	4	2	Student	6	No	Public			4	Micro	Study	6	20	5	10	45	10	Inconsistent	Current	Current	Current	Current	Before 8am
Female	Unmarried	2	4	3	Private_Job	4	No	Public			2	Micro	Work	2	30	3	7	20	10	Inconsistent	Alternative1	Alternative2	Current	Alternative4	8am to 11am
Male	Unmarried	1	6	1	Student	2	No	Public			2	Micro	Study	1.6	10	2	5	5	1	Consistent	Current	Current	Alternative3	Alternative4	8am to 11am
Male	Unmarried	1	5	2	Student	1	No	Public			2	Bus	Study	3	10	10	2	10	2.5	Inconsistent	Current	Alternative2	Current	Current	8am to 11am
Female	Unmarried	1	4	2	Private_Job	6	No	Public			4	Bus	Study	5	15	20	10	20	5	Inconsistent	Current	Current	Alternative3	Alternative4	11am to 4pm
Female	Unmarried	1	5	1	Government_Job	4	No	Public			2	Bus	Study	2	20	5	3	30	2	Inconsistent	Alternative1	Alternative2	Current	Current	8am to 11am
Female	Unmarried	1	4	2	Private_Job	6	No	Public			2	Tempo	Work	7	8	15	10	35	2	Consistent	Alternative1	Current	Alternative3	Alternative4	8am to 11am