Determining the Value of Time for a Proposed Expressway Along C-5

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Abstract: Metro Manila's congestion is indicative of the rising transportation demand in urban centers. In order to address this, the Metro Manila Integrated Transportation Study (MMUTIS) proposed the implementation of an expressway along Circumferential Road 5 (C-5). However, given the financial and economic risks involved in undertaking projects of this magnitude, an accurate estimation of Value of Time (VOT) is required in order to determine its viability. To obtain this, a binomial logit model was developed to forecast expressway demand and estimate road user value of time. A total of 672 responses were obtained through survey questionnaire which included socio-economic profile, trip characteristics and route choice components. Stated Preference was used to determine choice based from nine (9) scenarios of toll and time reduction. The developed model had a 65%forecasting accuracy with a 49.91% probability of C-5 private car users shifting to the expressway from their present routes. The calculated VOT was 121.67 pesos per hour supporting the viability of the expressway. However, VOTs were shown to vary from 47.81 pesos per hour to 266.38 pesos per hour depending on classification between trip characteristics, user profile and expressway usage.

Keywords: value of time, C5, expressway, discrete choice, route choice

1. INTRODUCTION

The present condition of traffic in Metro Manila's thoroughfares is a symptom of an increasing demand in urban centers. In order to resolve this, policymakers have often raised solutions ranging from mass transits to additional road space including development of infrastructures such as expressways (NEDA, 2014).

Comprehensive studies previously commissioned by the Government dates back from 1973 with the Urban Transport Study in the Metro Manila Area (UTSMMA) to more recent efforts with the Metro Manila Urban Transport Improvement Study (MMUTIS) which began in 1996. MMUTIS projected that if no additional infrastructures are provided by the year 2015, the average volume-capacity ratios will be at 2.3 which signified extreme congestion (MMUTIS, 1999). Among the recommended interventions was the expansion of Metro Manila's overall urban roadway system, which included the construction of an elevated expressway along Circumferential Road 5 (C-5), as shown in Figure 1. The expressway was envisioned to absorb traffic from the hubs of Makati, Ortigas and Cubao and to supplement North-South Axis of expressways comprised of Skyway, North Luzon Expressway (NLEX) and South Luzon Expressway (SLEX) (MMUTIS, 1999).

C-5 traverses the cities of Las Piñas, Makati, Marikina, Paranaque, Pasig, Quezon City, Taguig and the Municipality of Pateros beginning at the Manila-Cavite Expressway (CAVITEX) and ending at NLEX. The roadway currently has missing links particularly in the area of Paranaque and was originally intended to serve as a peripheral road complementary to Epifanio De los Santos Avenue (EDSA). Recent efforts to connect C-5 with CAVITEX through the missing link have been primarily a private sector initiative, through the C-5-Southlink Project (Velasco, 2016).

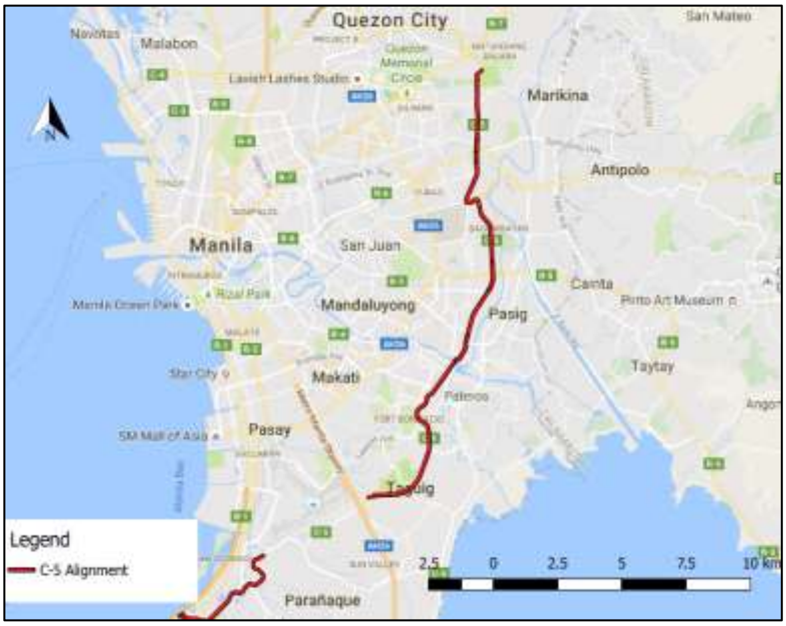

Figure 1. Vicinity Map of C5

Early traffic projections by UTSMMA in 1973 estimated that majority of intersection were within 20,000 to 60,000 vehicles per day by 1987. More recent observations made by Kawabata (2008) in select C-5 interchanges show that volume have been increasing since the past ten (10) years with values ranging from 80,000 vehicles per day (C5-Boni Serrano) to 158,000 vehicles per day (C5-Ortigas). The increase in traffic volumes paired with the lack grade separation in the major intersections of C-5 was pointed out to be the most likely cause of congestion in the roadway. In addition estimates from the Philippine Statistics Authority (PSA) point to a growth in population (2010-2015) as well as increasing incomes of residents (2009-2012) in most cities in the immediate vicinity of C-5 which will likely compound the present congestion in the area.

Given that these factors are likely to worsen the present traffic congestion in the area, the potential of interventions such as the C-5 expressway is worth exploring. However, the implementing an infrastructure project in a scale such as the C-5 expressway poses risks not only to investors but also to policymakers and stakeholders such as residents and local government units. In order to properly gauge and assess the potential benefits of undertaking the expressway, Small (2012) points to the need to determine the Value of Time (VOT) of road users. VOT is crucial with regards to traffic demand modelling and is often used to gauge the success for transportation policy decisions as stated by Small (2012).

The study therefore aims to determine the value of time of C-5 road users in order to gauge the potential viability of implementing the proposed expressway. This paper is organized as follows; the succeeding section reviews the related literature applicable to this study. The following section discusses the methodology used by the study to collect data and explain the developed model. The final section discusses the conclusions and recommendations made by this study.

2. REVIEW OF RELATED LITERATURE

2. 1 Route Choice

Traditionally, models used for route choice modeling have been based on the random utility theory on the assumption that travelers are rational and would seek to maximize their utility by selecting the best alternative to achieve this (Ortuzar and Willumsen, 2011). Various factors influence an individual's decision which are not only limited to trip related aspects for both public (i.e. travel time, access time and comfort etc.) and private (i.e. tolls, parking fees and fuel costs etc.) modes, but also the individual's socioeconomic profile (i.e. gender, income etc.) and demographics which complicates attempts to model a traveler's decision making (Raveau *et al.*, 2011). These factors were grouped by Jan *et al.* (2000) into three categories namely: traveler characteristics, route characteristics, trip characteristics and circumstances of the trip. Factors such as gender are known to have significant influence over route choice such as cases of females preferring toll roads more than men (Brownstone and Small, 2005, Knorr *et al.*, 2014).

Route characteristics were also shown to have significant impact on route selection. Abdel-Aty and Huang (2004) determined that, although motorists tended to select routes with shorter access distance to the expressway, they were also more willing to travel longer distances upon exit to reach their destinations. Zhang and Levinson (2008) observed that trip purpose together with the expected route characteristics was influential in route selection. Drivers were found to prefer routes with high speeds, reduced travel times, fewer stops, more efficient, easier drives and better aesthetics. The importance of attributes also varied with regards to trip purpose. Attributes relevant to route efficiency such as travel time, distance and number of stops were given more importance by work/event driven trips (visits, commutes, events) as compared to leisure trips.

2. 2 Value of Time

Another critical component with regards to route choice is the value of time (or value of travel time savings) which has been studied vigorously in various works. Cost-benefit analyses make significant use of travel time savings which are revealed in VOT studies as it reflects the benefits obtained by the users of transportation systems (Beaud, *et al.*, 2016). More specifically, the value of time is critical for several reasons such as being a part of decision making, being a necessary piece for travel demand modeling, and answers questions on human behavior which are utilized in economics (Small, 2005). This is reflected in time valuation studies for travel mode choice, as in the case of Garcia (2005) or route selection as in Alvarez *et al.* (2007). Previous studies have also utilized VOT in order to assess toll and road pricing policies as well as congestion charges (Alvarez *et al.*, 2007; Brownstone and Small, 2005; West *et al.*, 2016).

Several studies have shown that other factors which affect a traveler's value of time. Borjesson and Eliasson (2014) found that VOT varied based on income, employment, trip purpose etc as well as number of children in a household. The study by Tseng and Verhoef (2008) observed that gender played a key role with women drivers having higher values of time compared to men. Brownstone and Small (2005) and Knorr *et al* (2014) relate the value of time with reliability which was surmised to be caused by additional gender related activities such as child care which reduces their flexibility in scheduling. Huang (2002) identified the significance of employment as professional and self-employed individuals have higher VOT but flexible work hours suggesting more willingness to spend in order to avoid congestion compared to lower income earners. Similar observations were found in Tseng and Verhoef (2008) as well as Roxas and Fillone (2016) where higher income suggests more willingness to pay for travel time and low income suggests tighter constraints in schedules. Trip purpose was highlighted in the work of Alvarez *et al.* (2007) where it was found that work trips were generally valued higher compared to non-work trips. However, the opposite was observed by Jara-Diaz (2006) where it was found that leisure trips were valued higher compared to work trips in its Chilean sample, which was attributed to the poor quality of work suggesting that less stressful activities are valued higher. Similarly, Devarasetty *et al.* (2012) also determined that trips moving away from downtown central business districts (CBD), or trips away from work, were valued higher.

Hensher (2008) found that vehicle occupancy decreased average travel time savings as the number of passengers increase. Ho *et al.* (2016) on the otherhand conducted a comparative to study of the value of travel time savings between a lone driver, a passenger and a car with two (2) occupants (i.e. the driver and the passenger). It was revealed that vehicular value of time was better used compared with obtaining the VOT of the occupants separately as these were non-additive. Other factors which affect the decision making of travelers are associated with time related attributes according to a study by Li and Hensher (2012). The study revealed that car drivers were more willing to take risks with regards to travel time in incorporated into their decision making. The study explains that car travelers are likely to take a risk of travel time loss for corresponding chance of travel time gain.

3. METHODOLOGY

3. 1 Methodology

This study utilized a Multinomial Logit model based on Stated Preference (SP) data in order to determine the conditional probability of a traveler's selection between two alternatives, namely, the expressway and the current route. As mentioned in the previous section random utility dictates that traveler's would always seek to maximize their utility which is subject to constraints such as social, income, physical or a combination of these conditions (Ortuzar and Wilumson, 2011). The deterministic utility equation utilized by Alvarez *et al* (2007) shown in equation 1, expresses the utility between two alternatives based on the variables of time and cost.

$$V_1 = \alpha_T T_1 + \alpha_C C_1$$
$$V_2 = \alpha_T T_2 + \alpha_C C_2 \qquad eq. (1)$$

where,

V_1: Deterministic utility of alternative 1
V_2: Deterministic utility of alternative 2
T_i: Time variable for alternative i
C_i: Cost variable for alternative i
α_T: parameter for time variable
α_c: parameter for cost variable

The general equation utilized by studies such as Alvarez *et al.* (2007) and Ortuzar and Willumsen (2011) to determine choice probability for the MNL model is given in equation (2) with the assumed Gumbel distribution or Extreme Value Type 1 (EV1) for residuals/errors.

$$P_{in} = \frac{\exp(V_{in})}{\sum_{j=1}^{J} \exp(V_{jn})} \qquad eq. (2)$$

Where,

V_{in}: Systematic utility of chosen alternative i
V_{jn}: Systematic utility of alternatives j

Likewise, the computation for value of time used in this study is shown in equation (3), which incorporates the coefficient for cost-income ratio from Garcia (2005), into the basic value of time equation used in Antoniou *et al.* (2007) which is shown in equation 4.

$$VOT = \frac{\beta T}{\beta C} = \frac{\beta \text{Time}}{\beta \text{Cost} + \beta \text{Cstinc}(\frac{1}{Ave. Monthly\ Income})} x60 = \$/hr \qquad eq. (3)$$

$$VOT = \frac{\beta T}{\beta C} x60 = \$/hr \qquad eq. (4)$$

Where,

β_T: Coefficient of travel time
β_C: Coefficient of travel cost
β_{Cost}: Coefficient of travel cost (fuel, parking, toll)
β_{Cstinc}: Coefficient of cost-income ratio

3. 2 Experimental Design

The SP component of this study was defined in terms of the expressway's toll fee and the travel time reduced both as attributes of cost and time respectively. Each attribute was assigned three (3) levels which are shown in Table 1. A total of nine (9) scenarios were generated for the SP experiment as shown in Table 2. The levels of toll were on a per kilometer basis and were derived from the existing fares of the Metro Manila Skyway system (due to schematic similarities) with PhP 10/km serving as the base value. The low (PhP 7.50/km) and high (PhP 12.50/km) levels for toll represented a 25% decrease and increase from the base value respectively. The tolls presented to the respondents are dependent on their selected entry/exit location for the expressway which are shown in Figure 2.

Given the difficulty in establishing an exact value of travel time reduction for the expressway due to its hypothetical nature, the study utilized the concept used by Abdel-Aty *et al.* (1995). In the study, factors were multiplied (0.9, 1.1, 1.2 etc.) to the existing travel time in order to simulate the time for an alternative route. The study by Winston and Mannering (2014) mentioned that highways would translate to a 1/3 reduction of travel time. However, travel times obtained by Yazici *et al.* (2014) range from 50-120 secs/mile (1-2mins/mile) for highways and 3-7.5 mins/mile for urban roads. The difference in time between the two road facilities translates into at least 75% reduction by highways. Taking the median value between these two studies produced a time reduction of 50% which was set as the low value for this study. The high value of 70% was adopted in consideration of Yazici *et al.*, with the mid value of 60% being the median. Time reduction for this study was limited to the reduction provided by the expressway along C5 only as such these factors were applied to the respondents travel time in C-5 which was computed by subtracting the access and exit times to their total travel times.

Table 1. Attribute Levels

Attributes	**Unit**	**Level**		
		0	**1**	**2**
Travel Time Reduction along C5	%	50	60	70
Toll Fee	Php/km	7.50	10	12.50

Table 2. Generated set combinations from experimental design

Combination	**Travel Time Reduction**	**Toll Fee**
1	1	0
2	0	0
3	0	1
4	2	0
5	1	2
6	1	1
7	2	2
8	2	1
9	0	2

3. 3 Instrumentation

Data for this study was collected through survey questionnaires which were divided into three parts. The first and second components of the questionnaire are comprised of the respondent's trip information and socio-economic profile. These included, but were not limited to, origin and destination, purpose, frequency, vehicular occupancy, travel expenses (toll, parking, fuel) and total travel time form origin to destination, age, gender and marital status, educational attainment, household information (composition) personal and household incomes (per month). Additional information was also requested which included the intersection of entry into C-5 from their origin and intersection of exit from C-5 to destination as well as the travel time for both.

The final component of the questionnaire is the stated preference experiment which is discussed in more detail in the succeeding section. This component was used to gauge the reaction of the respondent when presented with a faster but costlier route in the form of the expressway. Respondents were asked to indicate which combinations of time and cost would encourage them to shift from their current route to the C-5 expressway. A sample of the questionnaire is shown in Appendix A.

3. 4 Sampling and Data Collection

The questionnaire was initially tested in a small size population of forty (40) respondents in order to determine its effectiveness in obtaining the desired data. The final version of the questionnaires was administered by surveyors to respondents through direct interview. The survey was concentrated in the cities surrounding C-5 with a focus on office and residential surveys. Questionnaires were administered in Ortigas, Marikina, Eastwood and Cubao. Surveys were also conducted in notable malls in C-5 such as UP Town Center and Market Market. Areas outside of Metro Manila were also considered through church surveys in Cavite. It should be noted however, that due to limitation on the part of the study, the small sample used may not be truly representative for the population of C-5 private car users.
The criteria in the selection of respondents are based on:

- Respondents use C-5 to reach their destinations regardless of travel frequency
- Respondents use private cars to travel along C-5 (specifically cars, SUVs, vans etc.).
- Respondents are adults who are 18 years or older
- Respondents with personal drivers were considered although it is assumed that the passenger is the primary choice selector

3. 5 The proposed expressway

The proposed expressway adopted by this study is shown in Figures 2 below, where the alignment follows that of the existing C5 road. A total of sixteen (16) entry/exit ramps were situated along major intersections with each assumed to have full access for both northbound and southbound directions of the expressway. Toll fee levels, as previously discussed, were based on a per kilometer fare, as such; matrices were developed for the three (3) levels and were presented to respondents in order to indicate their toll depending on their selected entry and exit points.

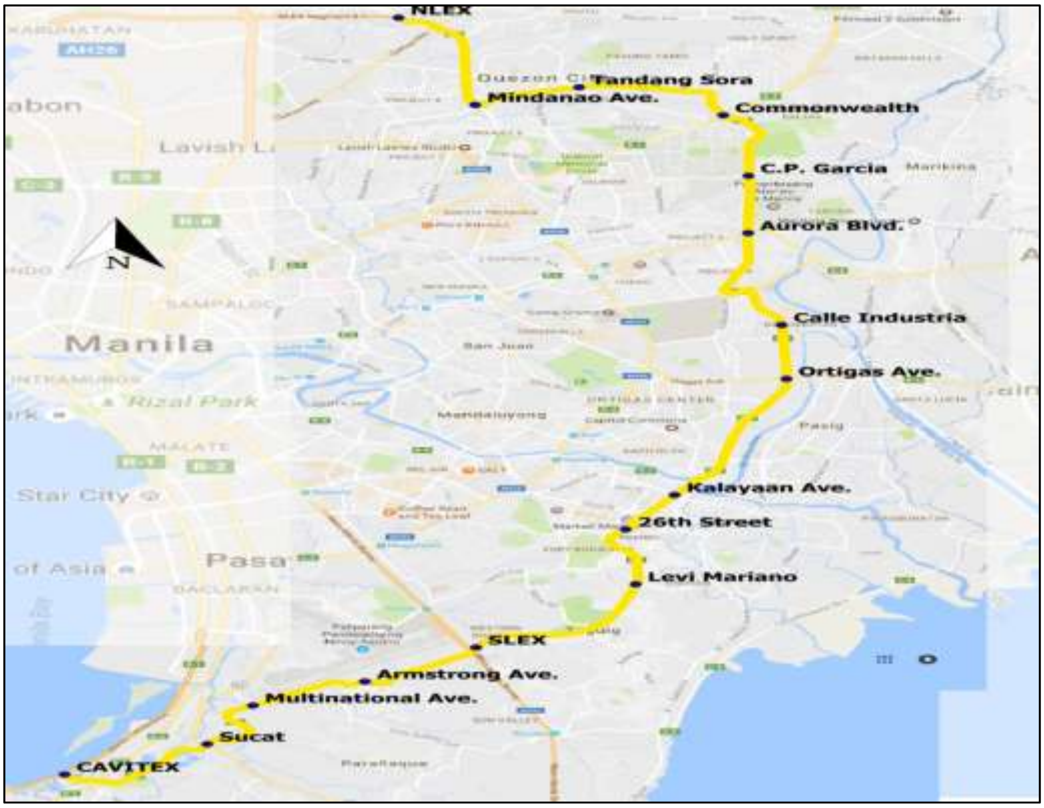

Figure 2. The Proposed Expressway along C5

4. RESULTS AND DISCUSSION

4.1 Socio-economic and Trip Characteristics of Respondents

A total of 672 responses were obtained from the survey. The socio-economic profile of respondents were relatively young being aged between 18 to 79 years old with most falling under the 20 to 40 year old age group (70.83%) and can be more appropriately described as part of the working age group. A majority of the sample were male (68%), married (56.70%), employed (70%) and highly literate with most being college educated (77%) and married (56%). The incomes of the respondents were classified based on the study of Villejo et al. (2009) where it was found that majority of the respondents are employed and fall within the middle income class when considering individual incomes (61%) and high income class when considering household incomes (63%). Average household size for the sample was four (4) people. The average number of working adults was found to be two (2) people for each household. The number of children had a mean value of one (1) child while the average number of seniors was determined to be 0.53 or one (1) per household..

The descriptive statistics for the quantitative variables of trip characteristics are presented in Table 3. Majority of trips in the sample were found to originate in Quezon City and Cavite, with the destination of most trips being towards the cities of Taguig, Quezon City and Pasig. Most of the trips made are those going to work (36%) and those going to social events (21%). The travel frequency of respondents were also found to vary widely with trips made monthly (13%), weekly (17%) and five times a week (12%) forming a significant portion of the data. It should be noted that careful observation of fuel expenses revealed discrepancies in the values of some response relative to trip distances. Also, not all responses were able to provide their corresponding fuel expense. Actual fuel expenses were subsequently calculated using trip distance and a derived fuel consumption rate of 8.14km/L based from estimates by Vergel and Tiglao (2013) for gasoline and diesel engines.

Table 3. Descriptive Statistics of Trip Characteristics

	N	Min	Max	Mean	Std. Deviation
Distance Origin to Destination	672	2	297	33.97	29.128
Vehicular Occupancy	672	1	18	2.43	2.441
Frequency of Trips	672	1	365	113.55	127.3
Trip Purpose	672	-	-	-	-
Toll	269	0	800	127.7	89.859
Fuel	590	18	2000	511.74	349.36
Fuel (Calculated)	672	13	1590	184.14	159.68
Parking	193	0	550	76.94	59.216
Time from Origin	672	0	160	30.88	25.159
Time to Destination	672	0	210	21.93	25.525
Total Travel Time	672	15	300	104.33	52.63

4.2 Results of Stated Preference Survey

The results of the stated preference experiment are illustrated below in Figure 3 which shows the number of respondents taking the expressway based from a total of 672 responses. It can be observed from the figure that as toll fee increases, respondents selection of taking the expressway decreases. The most commonly taken combinations were with the lowest toll fee which was 7.50 pesos per kilometer wherein majority of respondents selected it for all levels of time reduction. Additionally, scenarios with 70% time reduction were observed to be the most commonly taken from all three level of toll presented to respondents. The results may be interpreted as the respondents maximizing costs and are less willing to pay higher toll fees. This could also be indicative of sensitivity on the part of the sample to cost increases signifying willingness to endure longer travel times rather than incur additional trip costs.

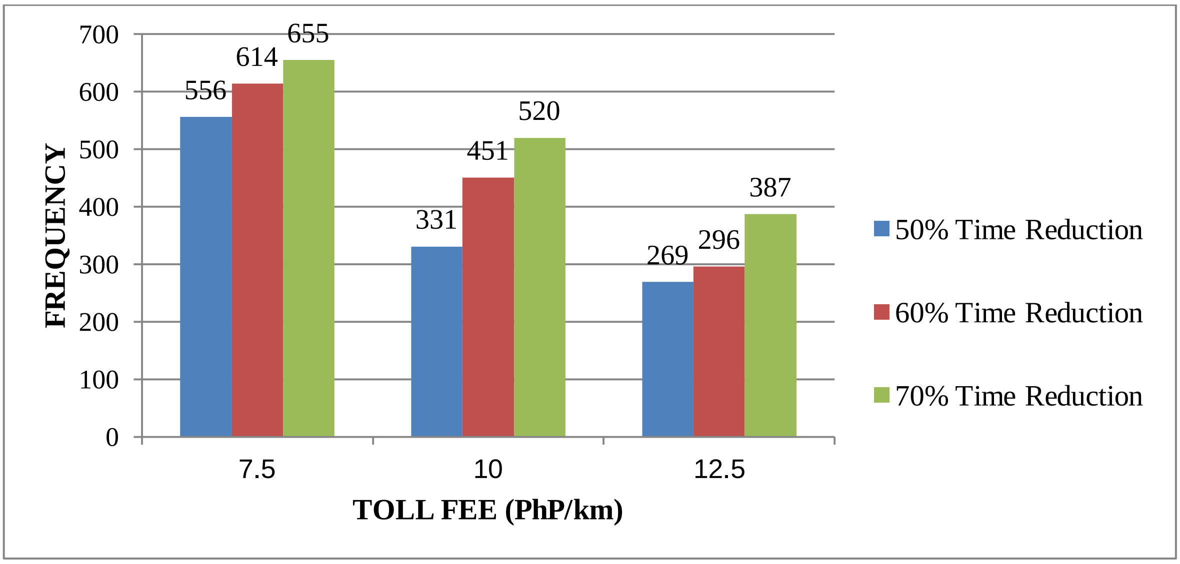

Figure 3. SP Results for Taking the C-5 Expressway

4.3 Model Estimation

The study developed a binomial logit model based from the respondents' utility between the expressway alternative and staying with their current routes. The developed model utilized seven (7) independent variables to determine choice as listed and defined in Table 4 with each being specified to be either generic to both alternatives or were specific only to the expressway. The utilities are given in equations 4 and 5 for the expressway and the current route respectively.

The parameter of travel time was broken down into three (3) components which were time travelled along C-5/expressway (CTIME), entry time to C-5/expressway (ATIME), and exit time to C-5/expressway (BTIME). CTIME was obtained by subtracting access and exit times then applying the three levels of time reduction. In cases were access/exit varied from the original point of entry and exit, changes in travel and access times were computed based from distances from origin to expressway entry, expressway distance travelled between entry and exit points and exit point to destination.

$$U(express) = \boldsymbol{CONSTANT} + \boldsymbol{COST} * TCOST2 + \boldsymbol{ATIME} * ATIME + \boldsymbol{BTIME} * BTIME + \boldsymbol{CTIME} * CTIME + \boldsymbol{CSTINC} * CSTINC + \%\boldsymbol{EXPD} * U1 + \boldsymbol{INDVEH} * INDVEH \qquad eq. (4)$$

$$U(current) = \boldsymbol{COST} * TCOST2 + \boldsymbol{ATIME} * ATIME + \boldsymbol{BTIME} * BTIME + \boldsymbol{CTIME} * CTIME + \boldsymbol{CSTINC} * CSTINC \qquad eq. (5)$$

Table 4. Definition of Variables used in the Model

Variable	Definition
CONSTANT	Alternative specific constant for the expressway
Generic Variables	
TCOST2	Total Cost of travel which includes parking, fuel expense (calculated) and applicable toll fees including for the C-5 Expressway
ATIME	Entry time from C-5 (for current route) and the C-5 expressway
BTIME	Exit time from C-5 (for current route) and the C-5 expressway
CTIME	Travel time along C-5 (for current route) and the C-5 expressway
CSTINC	Ratio between total trip cost incurred for the year over the individual annual income of the respondent
Alternative Specific	
U1	Ratio of expressway distance used by the respondent (from entry to exit) and the total length of the expressway
INDVEH	Vehicles individually owned by the respondent

The cost parameter was expressed through the total cost of a single trip which includes the respondents parking, toll fee and the estimated fuel expenses. Discrepancies in the fuel expenses provided by the respondents during the survey were noted. The calculated fuel expense was therefore used in place of that provided by the respondents with the variable named as TCOST2. Toll fees for the expressway alternatives takes into consideration the artificial toll for each scenario in addition to their existing toll. Additionally the cost income ratio represents the percentage of the annual trip cost relative to his/her annual individual income.

An alternative specific constant, CONSTANT, was assigned to the expressway with the current route functioning as the base alternative. Variables which were specific to the expressway were also considered. The respondent's usage of the expressway in terms of percentage is reflected by variable U1, which is the distance travelled between entry and exit over a total expressway distance of 38.42km.

A total of 6,048 observations were generated from 672 responses. Results of the model are shown in Table 5 presenting the corresponding coefficients and utility/disutility of each variable with all variables shown to be statistically significant. Despite being low, the R-squared and adjusted r-squared were considered as acceptable based from the analyses by Gignac and Szodorai (2016) which considered values of 0.20 to reflect medium effect sizes. The forecasting accuracy for the model was 64.94% or 65%. The model correctly predicts that 49.92% or roughly half would shift to the C-5 expressway which implies that a significant portion of road users are likely to use it.

Table 5. Model Estimation Results

	Coeff.	Std.Err.	t-ratio	P-value
CONSTANT	0.1732	0.0799	2.1670	0.0302
Generic				
COST	-0.0201	0.0010	-21.1425	0.0000
ATIME	-0.0086	0.0055	-2.9950	0.0027
BTIME	-0.0288	0.0055	-5.2035	0.0000
CTIME	-0.0037	0.0013	-2.9615	0.0031
CSTINC	-10.0892	0.5447	-18.5228	0.0000
Alternative Specific				
%EXPD	8.5073	0.4369	19.4723	0.0000
INDVEH	0.4557	0.0382	11.9273	0.0000
Summary Statistics				
R-Squared		0.24236		
Adj. R-Squared		0.24135		
Chi-squared (7)		1280.148		
Log Likelihood function		-3176.161		
Number of Observations		6048		
Sample Size		672		
Value of Time (PhP/hr)		121.67		

4.4 Value of Time

Using the developed model's estimated coefficients for the time and cost parameters as inputs for the VOT equation, the value of time was determined to be PhP 121.67/hr. The calculated value is higher compared with the MMUTIS estimates for 2015 where a VOT of 100.29 was projected (MMUTIS, 1999). This indicates a high willingness to pay on the part of the respondents for travel time reductions.

Multiple models were later developed by classifying the data into different subsets or categories. The VOTs obtained from these models are shown in Figure 4. The obtained VOTs for those using 50 percent or more of the expressway (PhP 140.78/hr) were found to be higher compared with those using less (PhP 108.37/hr) which implies greater importance placed on time for those with longer distances of travel. However, the VOT of those using shorter distances of the expressway may be dependent frequency of trip and expressway toll. Most variables were found to be significant with the exception of CTIME and ATIME for the less than 50% model.

In the case of gender, models revealed that females (PhP 263.33/hr) have higher VOTs compared to males (PhP 83.60/hr). This is supported by the works of Tseng and Verhoef (2008); Brownstone and Small (2005); and Knorr *et al*. (2014) which stated that a higher VOT for females is due to gender related activities such as child care. Similarly, a high VOT were observed for households with more than one child (PhP 153.08/hr) which is explained by Borjesson and Elliasson (2014) as due to activities such as pick up and drop off of children in school being prioritized by parents. All variables in the model were statistically significant with the exception to ATIME for females and CTIME for males.

Models based from the categories of trip purpose were also developed since related literature points to it exerting significant influence on how road users value time. Models were developed by grouping trips into work related (work, business, school) and non-work related trips (home, market, shop, social events). The VOTs for non-work (PhP 225.24/hr) was found to be significantly higher compared with work related trips (PhP 55.37/hr). Evidence can be found to support these results in Antoninou *et al.* (2007) and Jara-Diaz *et al.* (2006) where leisure trips were valued more compared to work trips. Based from these studies, the low VOT for work trips may be interpreted as the road users generally disliking work for a number of reasons such as long travel times, congestion etc. Time spent on non-work related trips on the other hand is perceived to be more valuable due to time spent with families or other activities which are less stressful and more enjoyable for the user (Antoninou *et al.* 2007). Similar results were observed from models based on trip frequency, where less frequent trips (PhP 196.79/hr) were significantly higher compared with more frequent ones (PhP 47.47/hr).

Classifying the data in terms of individual income produces more conventional results for VOT with Low, Middle and High incomes being PhP 104.38/hr, PhP 120.96/hr, and PhP 261.11/hr respectively. Statistical significance of variables varied from the models developed varied. CTIME and INDVEH were found to have no significance for low income respondents while exit times were found to be less significant for higher income respondents. The results were generally expected given that this coincides with findings from previous studies such as Devarasetty *et al.* (2012), Tseng and Verhoef (2008) and Roxas and Fillone (2016) where high VOTs were observed for higher income groups due to more flexibility in terms of income and are able to shoulder additional trip costs for reduced time.

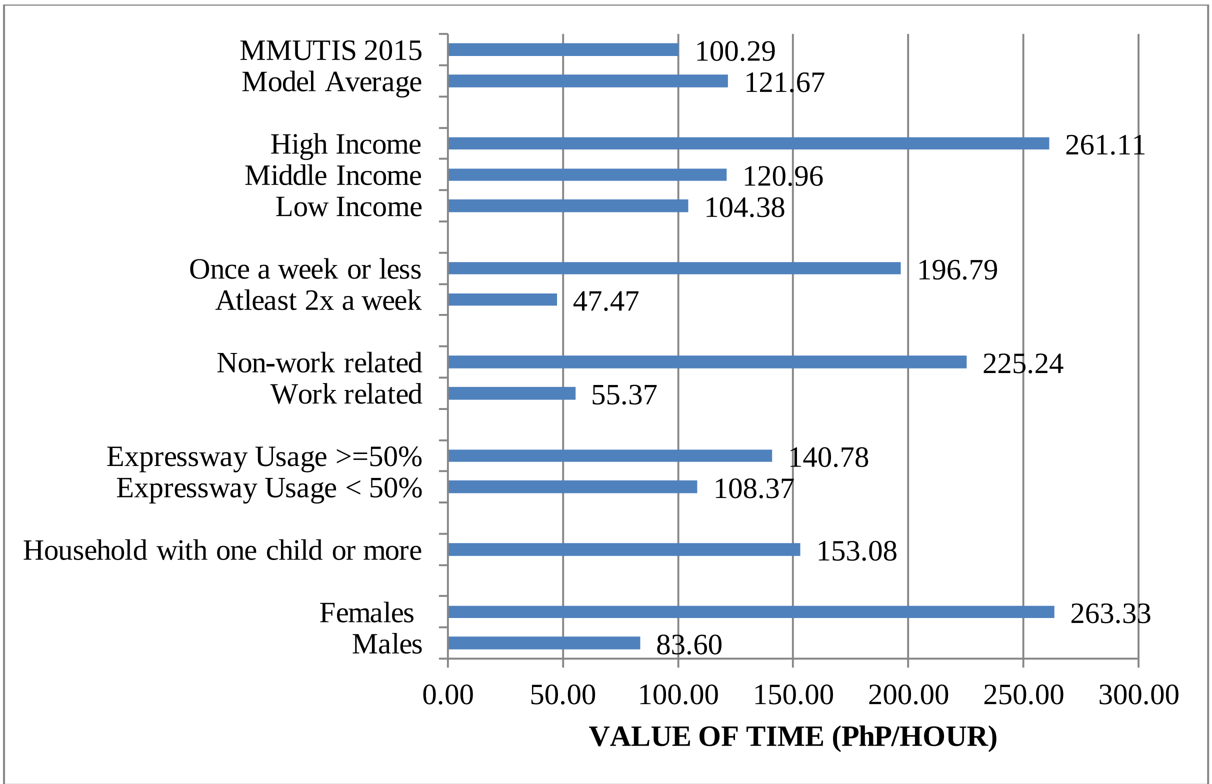

Figure 4. Comparison of Value of Time for Sub-Categories

5. CONCLUSIONS

The study is aimed to determine the viability of undertaking a proposed C-5 expressway by determining route choice patterns of road users and more importantly, their value of time. A total number of 672 respondents were obtained to develop a basic binary choice model based from multinomial logit models. The developed model had a relatively acceptable level of forecasting accuracy of 65% with a prediction of 49.91% probability of using the expressway. This indicates significant demand on road users for shifting to the expressway and suggests that the expressway is viable. Variables considered for the developed model include total travel cost, time travelled along C-5, entry and exit time, annual cost-income ratio, percent usage of expressway in terms of distance and individual vehicles owned. All of these variables were found to be statistically significant and have been shown to strongly affect route choice.

The value of time for private cars which was calculated from the model was PhP 121.67/hr which is higher than the estimated MMUTIS value for 2015 which was estimated to be 100.29 pesos per hour (for private cars). The high calculated VOT of the model indicates that road users are willing spend for time when travelling C-5 and also points to the potential viability of implementing the proposed expressway. Models made from sub-categories show wide variations of VOTs. Results from income groups were relatively within the range of the MMUTIS and the models VOT with high income individuals having the highest value which suggests that the expressway is likely to attract more high income earners. Similarly, high values of time were observed from certain groups especially when considering socio-economic factors such as gender and the presence of children in the household. The calculated VOTs when trip purpose and frequency were considered initially seemed questionable due to low values for work related trips. This could be interpreted, however, as the respondents valuing time spent with family or other more enjoyable activities compared to work although additional information is necessary to confirm this. Interestingly, when considering a respondent’s usage of the expressway, a higher value of time was observed for those who would use at least 50 percent of it in terms of roadway which is favorable given that expressway was generally intended to attract longer trips by connecting Metro Manila to outlying provinces.

6. APPENDIX A. SAMPLE QUESTIONNAIRE

Ref No. ______ Date: ______

TRIP INFORMATION

Please specify the Origin and Destination of the trip in which you use C-5

Place of Origin: ______
(Village/Barangay/Street name) (City)

Place of Destination: ______
(Village name/Barangay/Street name) (City)

Number of people in vehicle : ______

Trip Frequency

How often do you use C-5 to reach your destination?

- ☐ Daily
- ☐ 6 times a week
- ☐ 5 times a week
- ☐ 4 times a week
- ☐ 3 times a week
- ☐ 2 times a week
- ☐ Once a week
- ☐ Monthly
- ☐ Once in 2 months
- ☐ Once in 6 months
- ☐ Annually
- Others : ______

Trip Purpose

What is the most frequent purpose of the trip?

- ☐ To Work
- ☐ To Home
- ☐ To Business
- ☐ To School
- ☐ To Shop/Mall
- ☐ To Market
- ☐ To Social event
- Others: ______

Cost of Trip:

What are the costs involved when you travel in C-5?

Toll Fee: ______
Others (please specify): ______
Parking: ______
Fuel Expense: ______

Travel Time to destination:

What is the usual travel time for you to reach your destination?

- ☐ Less than 10 mins
- ☐ 10 to 20 mins
- ☐ 20 to 30 mins
- ☐ 30 to 40 mins
- ☐ 40 to 50 mins
- ☐ 1 hour
- ☐ 1 to 1.5 hours
- ☐ 1.5 to 2 hours
- ☐ More than 2 hours

What intersection do you use to ENTER C-5?

Enter: ______
Time to C5 from Origin (in mins) ______

What intersection do you use to EXIT C-5?

Exit: ______
Time from C5 to Destination (in mins) ______

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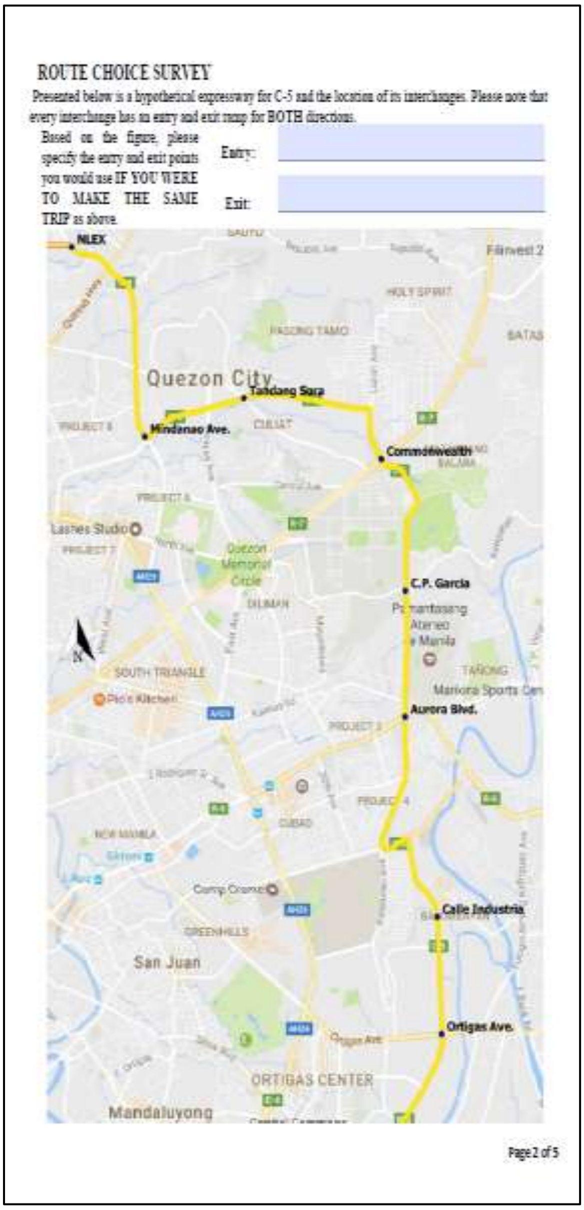
Figure A.1. Trip Information portion of the Questionnaire



ROUTE CHOICE SURVEY

Presented below is a hypothetical expressway for C-5 and the location of its interchanges. Please note that every interchange has an entry and exit ramp for BOTH directions.

Based on the figure, please specify the entry and exit points you would use IF YOU WERE TO MAKE THE SAME TRIP as above.

Entry:

Exit:

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Figure A.2. Route choice portion of the Survey

Below are nine (9) scenarios with varying combinations of travel time reduction and toll fee. For **EACH** scenario, kindly select whether you would choose to the take the expressway or remain with your current route. Please refer to the attached **TOLL MATRIX** for your corresponding toll.

Scenario 1	**Expressway**
Toll Fee	Php 7.50 per kilometer
Travel Time	60% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 2	**Expressway**
Toll Fee	Php 7.50 per kilometer
Travel Time	50% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 3	**Expressway**
Toll Fee	Php 10.00 per kilometer
Travel Time	50% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 4	**Expressway**
Toll Fee	Php 7.50 per kilometer
Travel Time	70% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 5	**Expressway**
Toll Fee	Php 12.50 per kilometer
Travel Time	60% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 6	**Expressway**
Toll Fee	Php 10.00 per kilometer
Travel Time	60% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 7	**Expressway**
Toll Fee	Php 12.50 per kilometer
Travel Time	70% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 8	**Expressway**
Toll Fee	Php 10.00 per kilometer
Travel Time	70% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

Scenario 9	**Expressway**
Toll Fee	Php 12.50 per kilometer
Travel Time	50% reduction from Travel Time in C5
☐ Take Expressway	☐ Retain current route

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Figure A.3. Route choice portion of the Survey

TRAVELER INFORMATION

Name (optional): ______ Age: ______ Civil Status: ______

No. of people in household: ______ Gender: ______

No. of seniors in household: ______ No. of children in household: ______

No. of working adults: ______ No. of children in school: ______

Highest Educational Attainment:
- ☐ Elementary
- ☐ High school
- ☐ College
- ☐ Masters
- ☐ Doctoral (Phd)
- ☐ Doctor of Medicine
- ☐ Law
- Others: ______

Employment Status:
- ☐ Employed
- ☐ Self Employed
- ☐ Retired
- ☐ Student
- Others: ______

Individual Income (monthly):
- ☐ Less than 10,000
- ☐ 10,000 – 14,999
- ☐ 15,000 – 29,999
- ☐ 30,000 – 49,999
- ☐ 50,000 – 69,999
- ☐ 70,000 – 99,999
- ☐ 100,000 – 119,999
- ☐ 120,000 – 139,999
- ☐ 140,000-249,999
- ☐ 250,000-499,999
- ☐ 500,000 and above

Household Income (monthly):
- ☐ Less than 10,000
- ☐ 10,000 – 14,999
- ☐ 15,000 – 29,999
- ☐ 30,000 – 49,999
- ☐ 50,000 – 69,999
- ☐ 70,000 – 99,999
- ☐ 100,000 – 119,999
- ☐ 120,000 – 139,999
- ☐ 140,000-249,999
- ☐ 250,000-499,999
- ☐ 500,000 and above

No. Vehicles Owned (Individual):
- Motorcycle: ______
- Car: ______
- SUV: ______
- Van: ______
- Others (Pls. Specify): ______

No. Household Vehicles:
- Motorcycle: ______
- Car: ______
- SUV: ______
- Van: ______
- Others (Pls. Specify): ______

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Figure A.4. Traveler Information/Socio Economic portion of the survey

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