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ASSESSING URBAN TRAVEL: A STRUCTURAL EQUATIONS MODELING (SEM) APPROACH

Alexis M. FILLONE
Assistant Professor
Department of Civil Engineering
De La Salle University-Manila
2401 Taft Ave., Manila, Philippines
E-mail: fillonea@dlsu.edu.ph

Cresencio M. MONTALBO Jr.
Associate Professor
School of Urban and Regional Planning
University of the Philippines-Diliman
Quezon City, Philippines
E-mail:cmontalbojr@yahoo.com

Noriel Christopher TIGLAO Jr.
Assistant Professor
Head, Urban and Regional Systems Analysis Group
National Center for Transportation Studies
University of the Philippines, Diliman
Quezon City, Philippines
E-mail: nctiglao@up.edu.ph

Abstract: Urban travelers doing work trips in the morning were divided into three groups; namely, (a) private car users, (b) public transport users with cars of their own or who have access to vehicles belonging to their households, and (c) captive public transport users who do not own a vehicle. Using Factor Analysis and SEM, latent variables were identified to reduce the more than 30 variables available for analysis. Comparison was then made regarding the differences in the significant variables of these three groups of travelers as they view urban travel. The main concern was in identifying variables important to car-owning but transit-using individuals that can be of significance when introducing travel demand management (TDM) measures that could encourage and attract car-using individuals to use public transportation. The results of this study are important in the planning of new TDM schemes that encourages the use of public transportation in Metro Manila.

Key Words: Structural equations modeling (SEM), latent variables, factor analysis, work trips, LISREL

1. INTRODUCTION

The use of road-based public transport systems, like buses and jeepneys, is more sustainable since more people can be carried per road space available and this mode uses less fuel per commuter compared to the use of private cars resulting to less pollution in the atmosphere. The application of TDM in urban transport planning is usually designed to encourage people using private cars to shift to public transportation. One TDM measure that is being implemented in Metro Manila today for the last six years is the number coding scheme that bans private car users on the road from 7AM to 7PM during one day of the week depending on the end number on the car's registration plate. In most areas however, there is a window period from 10AM to 3PM, where one can use the banned car. The prevailing compliance of the car-owning travelers to this TDM scheme suggests that people are amenable to regulations that are uniformly applied, properly implemented and regulated. On the other hand, it is possible that the scheme may have already outlived its usefulness considering the increasing volume of vehicles on the road and the minimal investment on urban road infrastructure. It is then important that other TDM schemes that encourage the use of public transportation should be introduced. Moreover, no study has been done yet that would conclusively point out the effectiveness of the number coding scheme in terms of reducing the number of vehicles on the road.

While the number coding scheme is just one of the many TDM approaches in reducing the number of vehicles on the road by encouraging people to use public transport, Yordphol (1992) has made a summary of TDM practices that has been in use in the South East Asian Region. This study however would not be focusing on TDM practices per se but on how urban travelers assess urban travel as they move from their home to the workplace in the morning. Only through a systematic understanding of the urban travelers' priorities when using their chosen mode and route can a well thought of TDM measure be designed and applied in Metro Manila. Pendyala, et.al. (2004) mentioned the necessity of determining the attitudes, values, experiences and perceptions of trip makers related to the performance, comfort, convenience, and importance of different modes and their attributes. Hence, the objective of this study is to identify the important characteristics and priority values regarding urban travel of the three groups of urban travelers. More specifically, what predisposes other car owning urban travelers to use public transportation when going to work in the morning.

2. METHODOLOGY

A questionnaire survey was done on urban travelers doing work trips in the morning from their homes to their workplaces. The respondents were divided into three groups; (1) the car-owning, car-using travelers, (2) the car-owning but frequent public transport users, and (3) the captive public transport users who do not own a vehicle. Car-owning means the traveler either own a personal vehicle or his household has at least one vehicle. The questionnaire used includes questions relating to the socio-economic and demographic characteristics of the traveler as well as his/her household like gender, age, civil status, average monthly income, average household monthly income, household size, car ownership, place of residence, work location, and the like. Information regarding the choice of mode of transport and the route taken as well as the average travel time and cost were also asked. The respondent was also asked to rate the importance of the attributes of urban travel aside from total travel time *(OTTIME)* and affordability of travel cost (*AFFORD*), such as, comfort (*COMFORT*), convenience and accessibility (*CONACC*), service reliability (*SRELIAB*), and order, safety and security (*ORDSASE*).

The number of samples obtained for the car-owning and car-using travelers was 428, for the car-owning but public transport using travelers a total of 217 samples while for the captive public transport users 191 samples. These numbers of samples were attained after removing those samples with missing data. The data was then processed into variables ready for the application of factor analysis. The aim of factor analysis is to reduce the number of p variables to a smaller set of parsimonious $K < p$ variables with the objective of describing the covariance among many variables in terms of a few unobservable factors (Washington, et.al., 2003). After the identification of important variables from factor analysis, these were then run into the LISREL software for the SEM process. Although the factor analysis method had identified more than 12 variables in the modeling process, the student edition of the LISREL software is limited only to run 12 variables. Hence, the 12 most significant variables were identified for each of the car-using and public transport-using but car-owning travelers and 11 for the captive public transport users and were then inputted in the SEM process.

Table 1. The Variables Used in the Modeling Process

Variable	Scale Value – Grouping	Variable	Scale Value – Grouping
AGE	0 – 19 yr. old and less 1 – 20 to 29 yr. old 2 – 30 to 39 yr. old 3 – 40 to 49 yr. old 4 – 50 to 59 yr. old 5 – 60 yr. old and >	***TRAVTIME*** Travel time of the traveler from home to work	0 – 15 min or less 1 – 16 to 30 min 2 – 31 to 45 min 3 – 46 to 60 min 4 – 61 to 75 min 5 – 76 to 100 min 6 – 101 min and above
STAYWP	Dummy variable: 1 – if stay with parents, 0 – otherwise	***OWNVEHIC***	Dummy variable: 1 – if own a vehicle, 0 – otherwise
CSTATUS	Dummy variable: 1 – if married, 0 – otherwise	***DRIVECAR***	Dummy variable: 1 – drive car to office, 0 – otherwise
YRDRIVE No. of years of driving	0 – Do not know to drive 1 – 3 yrs. or less 2 – 4 to 7 yrs. 3 – 8 to 12 yrs. 4 – 13 to 18 yrs. 5 – 19 to 25 yrs. 6 – 26 yrs. and more	***AFFORD*** Affordability of urban travel	Range of rating: 6 to 1 6 – very important 1 – least important
		NOCOMP	The number of companions in the car when going to the office
YRWCAR No. of years of car ownership	0 – Do not own 1 – 3 yrs. or less 2 – 4 to 7 yrs. 3 – 8 to 12 yrs. 4 – 13 to 18 yrs. 5 – 19 to 25 yrs. 6 – 25 yrs. and more	***COMFORT*** Comfort of urban travel	Range of rating: 6 to 1 6 – very important 1 – least important
		SRELIAB Reliability of service of urban travel	Range of rating: 6 to 1 6 – very important 1 – least important
CARALONE	Dummy variable: 1 – drive alone, 0 – otherwise	***CONACC*** Convenience and accessibility of urban travel	Range of rating: 6 to 1 6 – very important 1 – least important
INCOME Gross monthly income of the traveler	0 – Below Php5,999 1 – Php6,000 to 14,999 2 – Php15,000 to 19,999 3 – Php20,000 to 39,999 4 – Php40,000 to 99,999 5 – Php100,000 to 199,999 6 – Php200,000 and above	***ORDSASE*** Order, safety and security of urban travel	Range of rating: 6 to 1 6 – very important 1 – least important
		WORKOUTH	The number of household member working outside the house
TRAVCOST Total stated fare of the public transport user	0 – Php10 or less 1 – Php11 to 20 2 – Php21 to 30 3 – Php31 to 40 4 – Php41 to 50 5 – Php51 to 70 6 – Php71 and above	***RIDETIME***	0 – 15 min or less 1 – 16 to 30 min 2 – 31 to 45 min 3 – 46 to 60 min 4 – 61 to 75 min 5 – 75 to 100 min 6 – 101 min and above
HTYPE	Dummy variable: 1 – if owned the place, 0 – otherwise	***CHLDSCH***	Number of children going to school from kindergarten to college
HHSIZE	0 – 2 or less members 1 – 3 to 4 members 2 – 5 to 6 members 3 – 7 to 8 members 4 – 9 to 10 members 5 – 11 to 12 members 6 – 12 members and above	***HHADULTS***	0 – 2 or less adults 1 – 3 to 4 adults 2 – 5 to 6 adults 3 – 7 to 8 adults 4 – 9 to 10 adults 5 – 11 to 12 adults 6 – 12 adults and above

Hair, et.al. (1998) provides a concise description of SEM as a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously. Since factor analysis and SEM are suitable for variables measured on the interval scale, variables considered here were converted to interval scales and of metric measurement. Nonmetric dummy variables with the 0-1 coding were also used and a common practice in SEM analysis. The significant variables are shown in Table 1.

Other variables considered were gender, year of residence in the travelers' current address, presence of a driver's license, flexibility in check in time at the office, household gross monthly income, whether the traveler uses public transport and the length of time in years he/she has used public transport, and travel assessment on affordability and overall travel time.

3. ANALYSIS AND FINDINGS

3.1 Travel-Related Characteristics of Urban Travelers

From a questionnaire survey performed during the early half of the year 2004, Figure 1 shows the chosen alternatives of car users when their car is banned from using the road. The data shows that the highest alternative chosen is '*use another car*' with 171 (30.8%) of the 556 respondents. It is also interesting to note that 77 (13.8%) and 67 (12.1%) car users chose to '*use public transport*' and '*use taxi*', respectively. In Figure 2, those who use the car in going to work, 179 (44.6%) respondents out of the 401 who answered the question, drives to work alone. The average occupancy rate from this data is 1.8 persons/veh which is quite near the average occupancy rate of 1.75 person/veh from the Metro Manila Urban Transportation Integration Study (MMUTIS) done eight years ago.

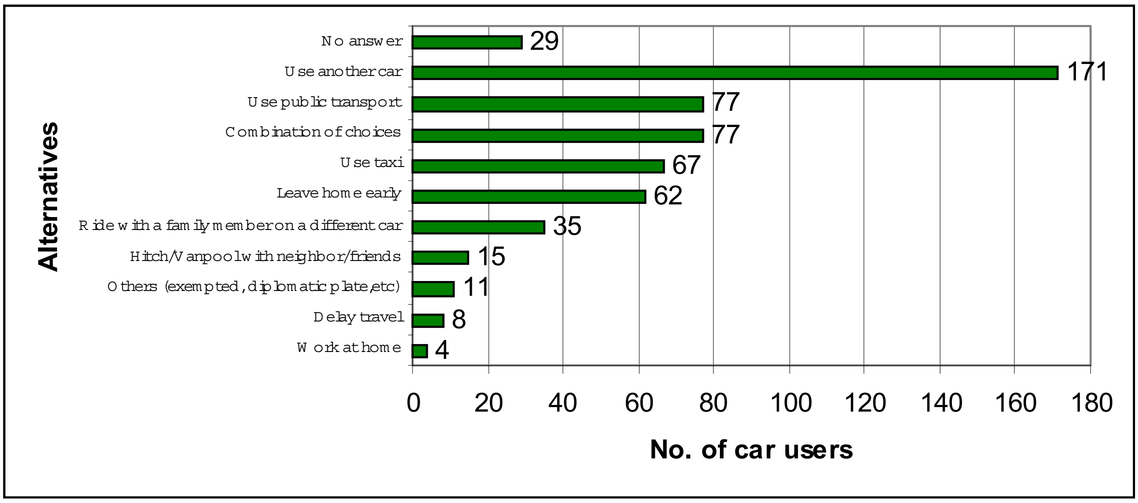

Figure 1. Car Users' Alternatives When the Car is Banned from Using the Road

In Figure 3, private car users were asked about their experience in using public transport in going to work. Of the 556 respondents, 159 (28.6 %) answered that they have used public transport '*a few days ago*'. It can be said that around 29 percent of the respondents use public transport consistently. On the other hand, 245 (44%) of the 556 respondents have 'never' or 'cannot remember' using public transport when going to work.

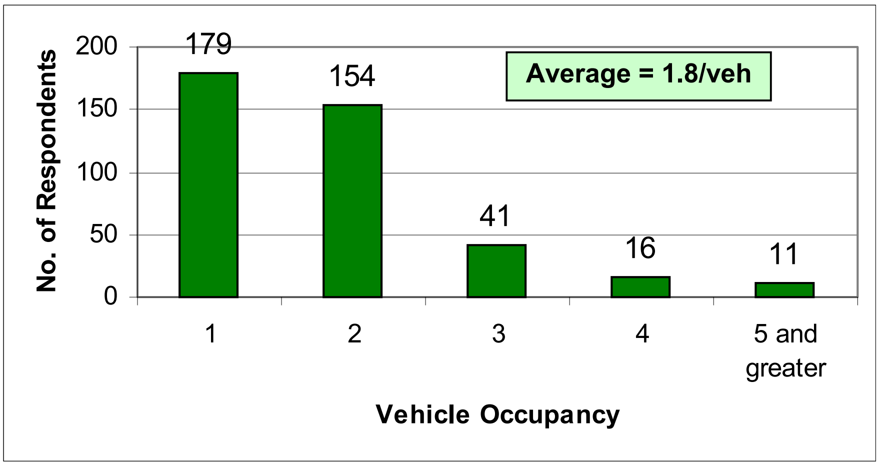

Figure 2. Car Occupancy in Metro Manila During the Morning Trip to Work

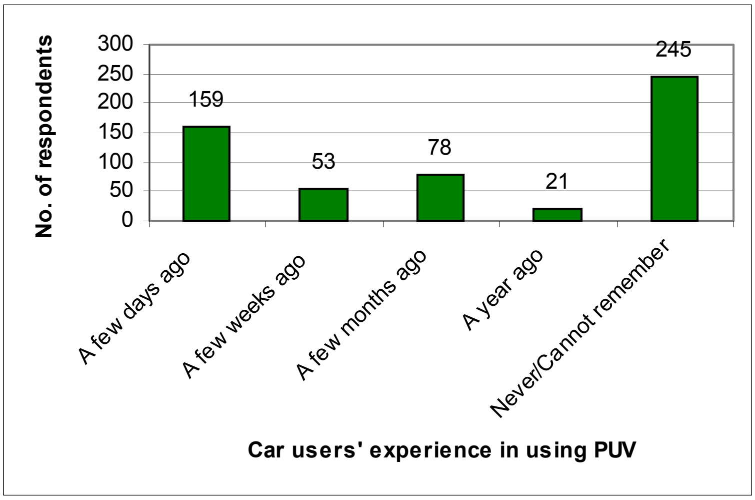

Figure 3. Car Users' Experience in Using PUVs

Having these facts about characteristics of car owners where some of them use public transport while others do not, it would then be interesting to determine the distinct characteristics of these three groups of urban travelers in their travel decision. If the characteristics of car owners who have the predisposition to use public transport could be known as well as the attributes of the urban transport system that they sought, these could be of importance in the design of new TDM schemes for Metro Manila.

3.2 Factor Analysis

Factor analysis was done in order to group around 30 variables into a reduced number of variables, termed factors that describe the characteristics of each of the three groups of urban traveler as well as the attributes of travel during the morning period when traveling from home to the workplace. When performing factor analysis, it is desired to identify the underlying relationships regarding travel in order to group the variables. A correlation matrix was first obtained between variables to assess their factorability. For the car-using travelers, inspection of the correlation matrix showed that out of the 66 correlations, 20 were significant at the .01 level, while for the public transport-using car owners, out of the 66 correlations, 24 were significant at the .01 level. However, for the captive public transport users, out of the 55 correlations only 10 were significant at the .01 level and 14 at .05 level of significance. These results are quite acceptable for factor analysis. Table 2 shows the acceptable results of the standard statistical tests for the three models, such as the Measure of Sampling Adequacy (MSA), Bartlett's Test of Sphericity, and individual variable MSA values, when doing factor analysis.

Table 2. Statistical Test in Factory Analysis

	Models		
	Car User	Public Transport User but Car Owner	Captive Public Transport User
Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA)	0.786	0.757	0.680
Bartlett's Test of Sphericity			
Approx. Chi Square	1604.056	1050.443	845.242
df.	66	66	55
Significance	.000	.000	.000
MSA Values of Variables	>0.50	>0.50	>0.50

The next step is to identify the number of components to be included for further analysis. Table 3 shows the data regarding the 12 possible variables concerning the car-using traveler and the attributes of travel and their relative explanatory power as expressed by their eigenvalues. The eigenvalues can also help in selecting what factors to be retained in the process. The method of latent root criterion was used in determining the number of factors to be extracted. Only factors having latent roots or eigenvalues greater than 1 is considered significant and all other factors with latent roots less than 1 are disregarded. Figure 4 shows that only three factors passed this criterion in the developed models for the three groups of urban travelers.

Table 3. Eigenvalues of the Twelve Factors for Car Users

Factors	Eigenvalues		
	Total	% of Variance	Cumulative %
1	3.714	30.948	30.948
2	1.877	15.644	46.592
3	1.434	11.950	58.542
4	.863	7.188	65.729
5	.739	6.161	71.890
6	.733	6.108	77.998
7	.693	5.772	83.770
8	.552	4.598	88.367
9	.479	3.992	92.360
10	.417	3.474	95.833
11	.307	2.557	98.391
12	.193	1.609	100.000

Since the factor loadings could range between –1 to +1, with those close to one (+1) suggesting that a variable is positively influenced by the factor. On the other hand, those that are close to negative one (-1) means the variable is negatively influenced by the factor. A factor loading near zero shows that the variable is not greatly influenced by the factor. For the private car user model, the 12 significant variables identified that have influence on the three identified factors using varimax rotation are shown in Table 4.

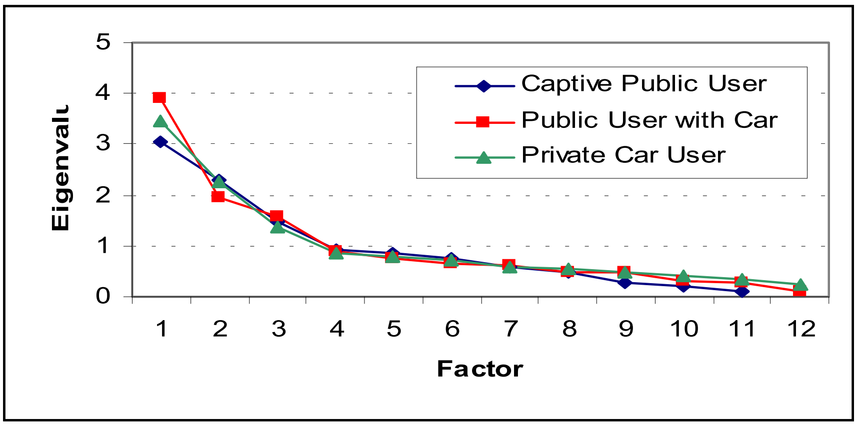

Figure 4. Eigenvalues of the Models Using the Scree Plot

Table 4. Varimax Rotation of Factor Loadings of Private Car Users

	Factor		
	1	2	3
Individual Sociodemographic Characteristics			
AGE	.833	-.156	
YRWCAR	.787		
CSTATUS	.751	-.194	.139
INCOME	.732		
YRDRIVE	.695	.278	
STAYWP	-.671		
Car Travel Experience			
CARALONE	-.102	.903	
NOCOMP	.138	-.837	
DRIVECAR	.133	.774	
Assessment of Urban Travel			
CONACC		-.126	.727
SRELIAB			.696
COMFORT		.130	.614

Note: Loadings <0.10 were not shown.

Varimax rotation was used instead of the unrotated factor loadings for clearer and better interpretation of relationships between the variables and factors. Factor loadings less than 0.10 were not shown. The first set of variables that loads on the first factor was termed *sociodemographic characteristics* of the urban traveler. Such variable as age (*AGE*), number of years of car ownership (*YRWCAR*), civil status (*CTATUS*), personal income (*INCOME*) and car driving experience (*YRDRIVE*) has a positive influence on the first factor but staying with parents (*STAYWP*) has a negative influence. The second set of variables that loads on the second factor was termed *car travel experience* since the variables have something to do with driving the car. Both driving the car (*DRIVECAR*) and being alone (*CARALONE*) have great influence on the second factor while the number of companions (*NOCOMP*) negatively influences it. The third set of variables has something to do with the assessment of the car user of urban travel and it shows that convenience and accessibility (*CONACC*), service reliability (*SRELIAB*), and comfort (*COMFORT*), all positively load on the third factor. Similar process was also done on the data of car owning public transport users and the captive public transport users and the varimax rotation of their factor loadings are shown in Tables 5 and 6, respectively. It can be seen in Table 6 for the factor analysis result of the captive public transport users that *HHSIZE, HHADULTS, WORKOUTH, CHLDSCH,* and even *STAYWP,* are variables describing the household sociodemographic characteristics of the individual and are more significant indicators than the personal sociodemographic characteristics of the traveler. The resulting SEM models for the three groups are discussed in the next section.

Table 5. Varimax Rotation of Factor Loadings of Public Transport Users but Car Owners

	Factor		
	1	2	3
Individual Sociodemographic Characteristics			
AGE	.825	.106	
CSTATUS	.797	.152	
STAYWP	-.775	-.100	
OWNVEHIC	.736		.156
HTYPE	.719	.287	
INCOME	.645	-.116	
Generalized Cost of Urban Travel			
RIDETIME	.133	.935	
TOTTIME		.921	
COST	.104	.670	
Assessment of Urban Travel			
ORDSASE			.778
SRELIAB			.760
CONACC	.114		.648

Note: Loadings <0.10 were not shown.

Table 6. Varimax Rotation of Factor Loadings of Captive Public Transport Users

	Factor		
	1	2	3
Household Sociodemographic Characteristics			
HHSIZGRP	.928		.129
HHADUGRP	.920		
WORKOUTH	.783		
CHLDSCH	.626		.191
STAYWP	.367		
Generalized Cost of Urban Travel			
RIDETIME		.900	.106
TOTTIME		.887	
COST		.808	
Assessment of Urban Travel			
ORDSASE			.792
SRELIAB	.126		.695
COMFORT		.104	.665

Note: Loadings <0.10 were not shown.

3.3 Structural Equation Modeling

Before going into the detail of the important variables considered in the SEM models, the goodness of fit of the models were first assessed. Goodness of fit measures can be divided into absolute fit, incremental fit, and parsimonious fit measures. Hair, et.al. (1998) defined absolute fit measure as a measure of overall goodness-of-fit for both the structural and measurement models, incremental fit measure as a measure of goodness-of-fit that compares the current model to a specified null model to determine the degree of improvement over the null model, and parsimonious fit measure is a measure of overall goodness-of-fit representing the degree of model fit per estimated coefficient. The last measure attempts to correct for any "overfitting" of the model and evaluates the parsimony of the model compared to the goodness-of-fit. The type of tests for each of the measures and the corresponding results for the developed models are shown in Table 7 and are the results of the LISREL software.

Table 7. Goodness of Fit Measures of the Models Developed

Fit Measures	**Models**		
	Car Users	**Public Transport Users with Car**	**Captive Public Transport Users**
Absolute Fit Measures			
Likelihood ratio chi-square statistic (χ^2) (P-value)	64.08 df.=66 (0.04000)	93.35 df.=66 (0.00020)	85.08 df.=55 (0.00006)
Noncentrality parameter (NCP)	18.08	43.35	44.08
Goodness-of-fit index (GFI)	0.98	0.93	0.92
Root mean square residual (RMSR)	0.053	0.11	0.13
Root mean square error of approximation (RMSEA)	0.030	0.063	0.075
Expected cross-validation index (ECVI)	0.30	0.69	0.71
Incremental Fit Measure			
Normal fit index (NFI)	0.97	0.93	0.89
Adjusted Goodness-of-fit index (AGFI)	0.96	0.90	0.88
Parsimonious Fit Measures			
Parsimonious goodness-of-fit index (PGFI)	0.58	0.60	0.57
Parsimonious normed fit index (PNFI)	0.68	0.70	0.66
Model Akaike information criterion (AIC)	128.08	149.35	135.08

Absolute Fit Measures. For the measure of absolute fit, the three most basic measures are the likelihood ratio chi-square statistic, the goodness-of-fit index and the root mean square residual. The chi-square values of the car-using, public transport-using but car-owning, and captive public transport users are 64.08, 93.35, and 85.08, respectively, and are statistically significant at 95 percent degree of confidence. Another very 'rough rule of thumb' used regarding the measure of absolute fit is when the ratio of the χ^2 to the degrees of freedom (df) is less than 2 (Tabachnick, et.al., 2001) and all the three models passed this rough rule. The NCP values are 18.08, 43.35, and 44.08, for the three models, respectively. The GFI values are 0.98 for the car user model, 0.93 for the public transport-using but car-owning traveler, and 0.92 for the captive public transport user model, showing good fit of the three models using this measure. The RMSR of the car user model is lower at 0.053 compared to 0.11 for the public transport user but car-owning model and 0.13 for the captive public transport user model. Other measures like the RMSEA, with acceptable range of 0.08 or less, shows that the three models are way above the accepted value. The ECVI of the car user model is also lower compared to the other two. Overall, the private car user SEM model is better than the other two models in the absolute fit measure category.

Incremental Fit Measures. The incremental fit measure assesses the incremental fit of the model compared to a null model, where the null model is hypothesized as a single-factor model with no measurement error. The desired threshold for this measure is 0.90, and the NFI and AGFI for the private car user model are 0.97 and 0.96, respectively, while that of the public transport user but car owner, the values are 0.93 and 0.90, respectively. In the case of the captive public transport user model, the values are 0.89 and 0.88, respectively, are a shade below the desired threshold value.

Parsimonious Fit Measures. This type of measure is best when comparing several developed models for a given data set in order to choose which model could best described the variables' relationships. While the data of the three developed models came from different data sets, the comparison will only be done as to which model is most fit to describe the data used. Using the three measures of PGFI, PNFI, and AIC, the captive public transport user model developed is better on the PGFI and PNFI at 0.57 and 0.66, respectively compared to the other two models. However, the private car user model has a better AIC of 128.08 among the three.

In summary, the three SEM models developed have respectable goodness-of-fit results, and hence further warrant the discussion of the details of the measurement and structural models of each. Tables 8, 9, and 10 show the loadings for the measurement models of car users, public transport using but car-owning, and captive public transport users, respectively. Figures 5, 6, and 7 show the graphic representation of the models of the three types of urban travelers in LISREL.

Car User Model. As the result of factor analysis has shown, three factors were identified and the corresponding variable loadings. In Table 8, the first factor termed as the socio-demographic characteristic of the car user, include variables that load positively as age, number of years having owned a car, civil status, monthly income, and years of driving experience. However, staying in ones parents' house negatively loads on the first factor. This is so since those who usually stay at ones parents are those young professionals just starting out after college who are usually not married, with lower salaries, and uses his/her parents' car. The second factor has something to do with the driving aspect and the number of companions inside the car is a negative loading. Naturally when he is driving alone means he has no companion giving it a positive loading. This result simply confirms the descriptive statistics previously discussed that showed majority of car drivers going to the office travel alone. Going into the endogenous construct, which can be termed as the travel assessment of the car-using traveler, it can be said that *service reliability*, *convenience and accessibility*, and *comfort* are the priority values of an urban traveler that drives a car when going to the office.

Hence, if we are to encourage the car-using traveler to shift to public transport service, these aspects of travel using public transportation have to be properly addressed. Only the exogenous constructs of socio-demographic characteristics load positively on the endogenous construct of travel assessment while the car travel assessment loads negatively.

Table 8. Measurement Model Equation (Private Car Users, N = 428)

Exogenous Indicators	Exogenous Construct		t-value	Error
	Sociodemographic Status, X1	Car Travel Experience, X2		
AGE	0.90	-0.15	19.60	0.38
YRWCAR	1.16	0.04	16.73	1.14
CSTATUS	0.34	-0.09	15.70	0.12
INCOME	0.93		14.03	1.21
STAYWP	- 0.28		-13.03	0.13
YRDRIVE	1.07	0.26	14.24	0.53
CARALONE		0.48	21.96	0.01
NOCOMP		-0.74	-16.43	0.41
DRIVECAR		0.22	12.04	0.10
Endogenous Indicators	Endogenous Construct			
	Assessment of Travel, Y1			
SRELIAB	1.00			1.70
CONACC	0.96		3.29	1.50
COMFORT	0.74		3.44	2.19
Structural Model Equation				
Endogenous Construct	Exogenous Constructs X1 X2			
Y1	0.15X1 – 0.01 X2		2.41	0.54

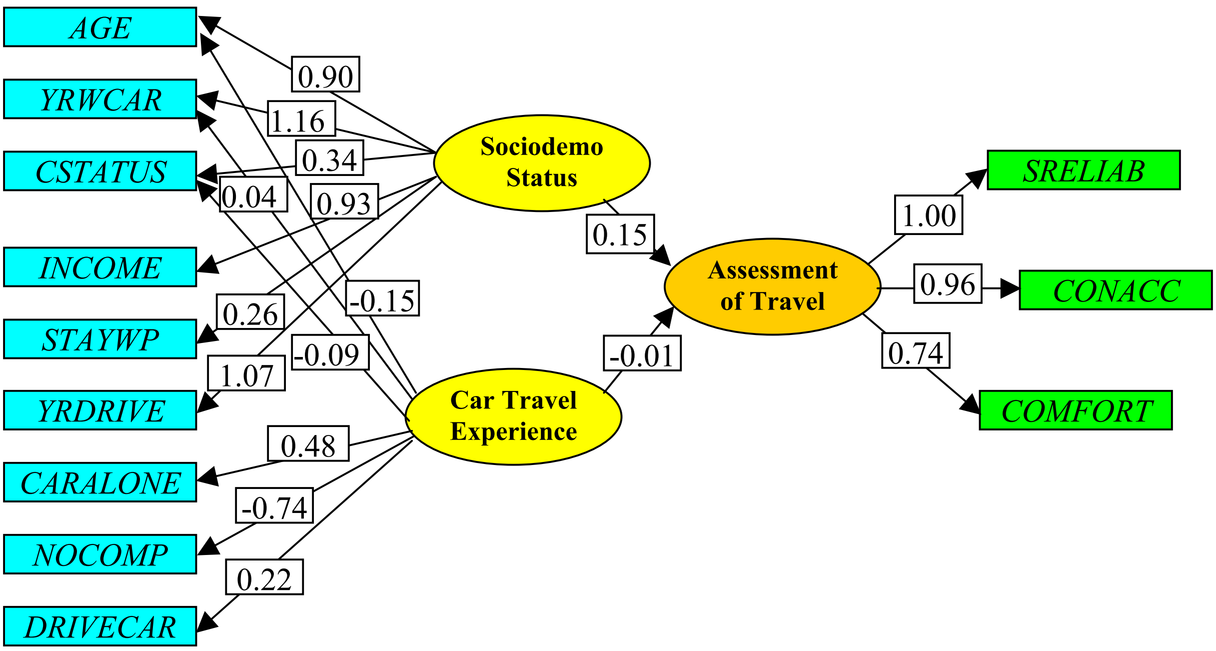

Figure 5. LISREL Graphic Representation of the Car User Mode

Table 9. Measurement Model Equation (Public Transport Users With Car, N=217)

Exogenous Indicators	Exogenous Construct: Sociodemographic Status, X3	Exogenous Construct: Generalized Cost of Travel, X4	t-value	Error
AGE	0.86		14.01	0.30
CSTATUS	0.36		12.60	0.10
HTYPE	0.32	0.08	11.06	0.11
STAYWP	- 0.40		-12.76	0.09
OWNVEHIC	0.32		10.22	0.14
INCOME	0.53		7.81	1.08
RIDETIME		1.69	17.77	0.04
TRAVTIME		1.52	15.19	0.62
TRAVCOST		0.91	7.80	2.38
Endogenous Indicators	Endogenous Construct: Assessment of Travel, Y2			
ORDSASE	1.00			1.69
CONACC	0.52		3.66	1.91
SRELIAB	0.76		3.68	1.55
Structural Model Equation				
Endogenous Construct	Exogenous Constructs X3 X4			
Y2	0.18 X3 + 0.07 X4		1.59	1.41

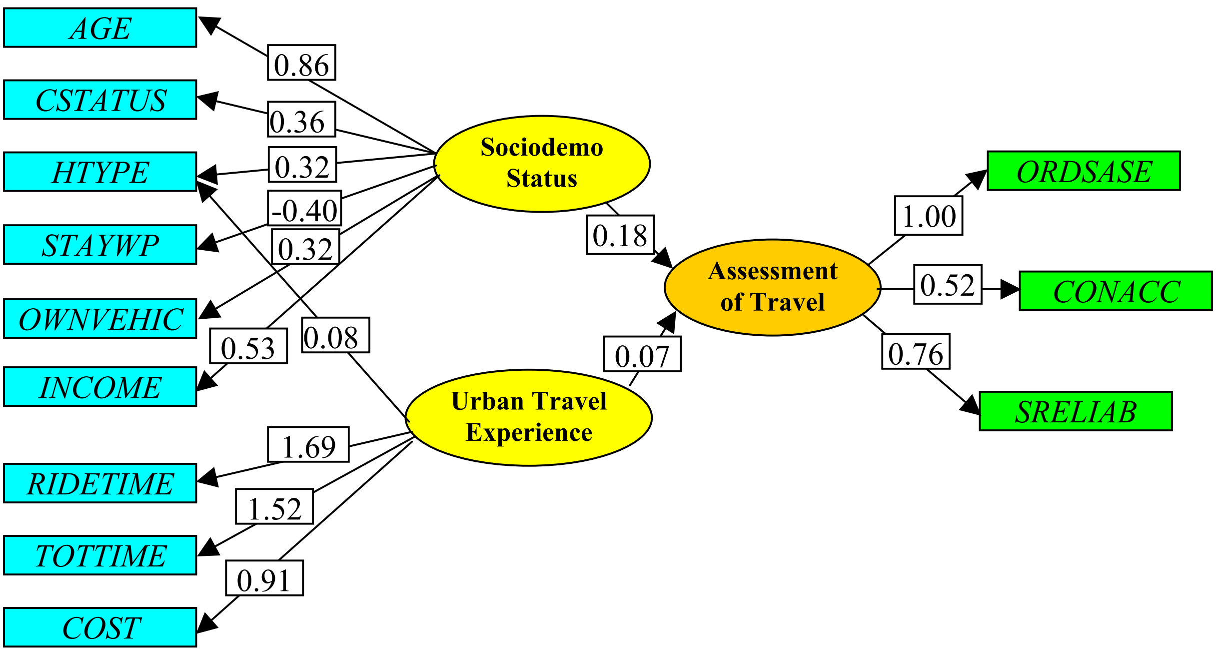

Figure 6. LISREL Graphic Representation of the Public Transport User but Car Owning Model

Table 10. Measurement Model Equation (Captive Public Transport Users, N=191)

Exogenous Indicators	Exogenous Construct		t-value	Error
	Household Sociodemographic, X5	Generalized Cost of Travel, X6		
WORKOUTH	1.18		10.61	1.56
HHSIZEGRP	1.24		15.86	0.29
HHADUGRP	1.09		16.14	0.18
CHLDSCH	0.90		9.38	1.11
STAYWP	0.12		3.50	0.20
RIDETIME		1.56	14.10	0.53
TRAVTIME		1.48	13.07	0.82
TCOSTGRP		1.01	9.21	1.53
Endogenous Indicators	Endogenous Construct			
	Assessment of Travel, Y3			
ORDSASE	1.00			1.63
COMFORT	0.58		3.35	2.12
SRELIAB	0.61		3.39	1.87
Structural Model Equation				
Endogenous Construct	Exogenous Constructs X5 X6			
Y3	0.28 X5 + 0.18 X6		2.27	1.50

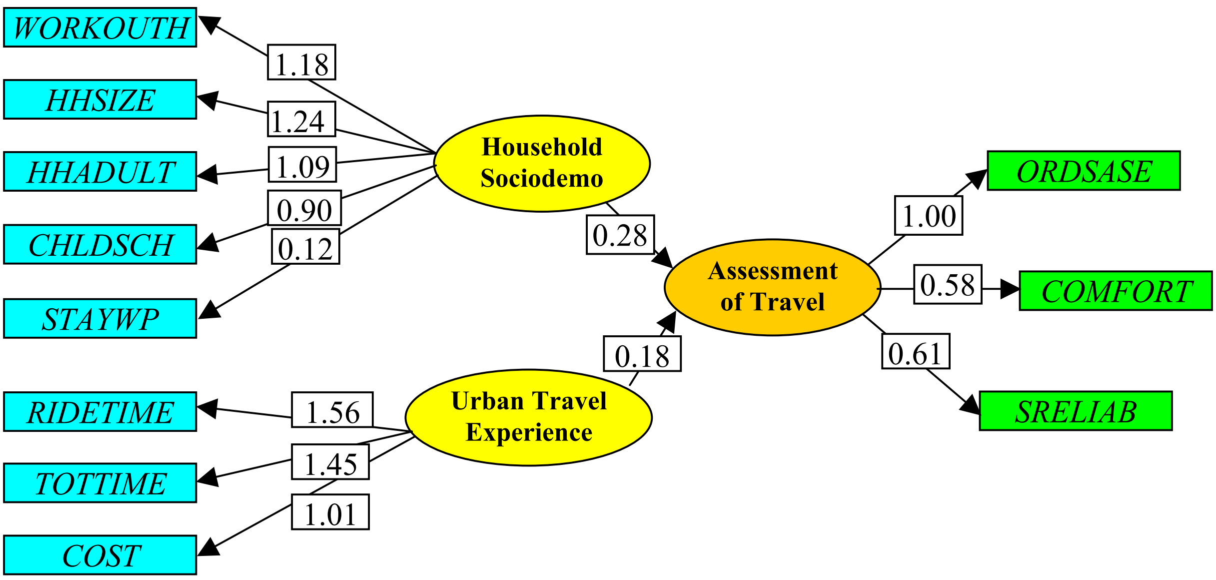

Figure 7. LISREL Graphic Representation of the Captive Public Transport User Model

Public Transport User but Car-Owning Model. For the public transport user but car-owning model (Table 9) under the first factor also termed as socio-demographic status of the traveler, those variables that load positively are age, civil status, ownership of the place of residence, ownership of a vehicle, and individual monthly income. In the same manner, staying with parents again load negatively for the same reason mentioned previously. The second factor concerns with the generalized cost of travel, which is simply the total ride time, total travel time and travel cost. The endogenous constructs that were identified by public transport users that load positively are *order, safety and security*, *convenience and accessibility,* and *service reliability*. Comparing these priority values with that of the previous model, *order, safety* and *security* replaced *comfort*, indicating that for this group of travelers, when riding the public transport system order, safety and security is more important than comfort. The on-going threat of terrorism coupled with previous experiences on acts of terrorism on the public transport system in Metro Manila are major concerns of the riding public. The exogenous constructs of socio-demographic characteristics and generalized cost of travel load positively on the endogenous construct of travel assessment.

Captive Public Transport Users Model. For the captive public transport users, the variables that load positively are the number of household members working outside the house, household size, number of adults (18 yrs. old and above) in the household, number of children going to school, and likewise, the household-related variable of staying with parents. These indicator variables can be termed as household sociodemographic characteristics. This may mean that for the captive public transport users, household characteristics are more important than individual characteristics in their travel decision and in the way they assess urban travel. In the same manner, the second factor concerns with the generalized cost of travel, specifically, the total ride time, total travel time and travel cost. The endogenous constructs that were identified by the captive public transport users that load positively are *order, safety and security*, *comfort,* and *service reliability*. These constructs are not much different from the two models previously discussed. It can also be said here that *affordability*, which was one of the choices on travel assessment did not stood out in any of the models. This may mean that for urban travelers, the current fare structure of the public transport system in Metro Manila as well as the out-of-pocket cost involve in driving a car to the office are not important issues when traveling in the morning going to the office. The exogenous constructs of the household sociodemographic characteristics of the traveler and generalized cost of travel load positively on the endogenous construct of travel assessment.

CONCLUSION AND RECOMMENDATION

The developed models may not be the best-fit models developed from the current data using Factor Analysis and SEM. However, several interesting interrelationships were obtained that could help explain how the three groups of travelers assess urban travel in Metro Manila during the morning trip to work. As the results would show, quite different measurement and structural models and the corresponding manifest and latent variable loadings were obtained in the SEM models of the three groups of urban travelers. Regarding the latent variables identified, for the private car users, the latent variable relating to the socio-demographic characteristics of the traveler load positively while the latent variable relating to car travel experience load negatively on the assessment of urban travel. In the case of the public transport-using but car-owning traveler, both the socio-demographic characteristic of the traveler and the generalized cost of travel load positively on urban travel assessment. However, for the captive public transport user model, it is the household socio-demographic characteristic as well as the generalized cost of travel that load positively on urban travel assessment. This latter group would indicate the importance of the household characteristics more than the individual characteristics in the assessment of urban travel. This may also indicate that the urban travel decision of the individual in a non-car-owning household is affected by the household characteristics.

Regarding the endogenous constructs, what are important to car-using individuals are trip attributes of *service reliability, convenience and accessibility,* and *comfort*, reinforcing characteristics if you are using the car when going to the workplace. Hence, when a new TDM scheme is to be introduced that would encourage the use of public transportation by the car-owning urban travelers; these mentioned attributes should be taken into consideration. For car-owning but transport-using individuals, *order, safety and security, convenience and accessibility* and *service reliability* are what counts. For the captive public transport users, *order, safety* and *security*, *comfort*, and *service reliability* are the important constructs in their assessment of urban travel. The first attribute being important in view of the terrorism problem that beset Metro Manila today as previous acts of terrorism has targeted the public transport system.

Since affordability of the public transport system is not an issue to this groups, TDM schemes that may include the attributes that they value although with fare levels that may be higher than the present could be considered.

If more than 12 variables could be run in LISREL, more theoretical variable relationships could have been modeled, tested and developed.

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