# FORMULATION OF THE MODELING FRAMEWORK OF PANEL ANALYSIS APPLICATION IN A DEVELOPING COUNTRY – Metro Manila: A Case Study

Tohru Tamura
Assc. Professor
Muroran Inst. of
Technology, Japan

Hussein S. Lidasan
Ph.D. Student
Tsukuba University
Japan

Takeshi Kurokawa
Professor
Tsukuba University
Japan

## 1. INTRODUCTION

### 1.1 Objectives of the Study

The rapid urbanization in most metropolitan regions in developing countries, notably in Southeast Asia, led to swift deterioration of urban transport and traffic conditions resulting to enormous traffic congestion and inadequate transport facilities. To cope with these growing concern, new mass transport systems, such as MRT in Singapore and LRT in Metro Manila, and responsive transport policies and measures were developed. These developments coupled with external factors influenced people's travel behavior and trip decisions. Thus, new academic approach would seem to be appropriate in studying these phenomena. One particular approach is the utilization of panel data (data obtained from observing a specific sample over two or more periods in time) in analyzing changes in people's travel behavior.

This approach has been explored and undertaken in the developed countries to analyze and study many aspects and issues of travel behavior which could not be tackled by cross-sectional analysis. However, there has been no panel studies conducted yet in the developing countries in studying travel behavior. Accordingly, this paper hopes to present and discuss the attempt of introduce panel analysis in a developing country. For this purpose, a panel survey was tried in Metro Manila in 1990 with the belief that such a survey is possible in that region and hopefully in the developing countries in general. A 1987 transport survey in Metro Manila was considered to be the first wave for the 1990 panel survey.

The primary objective of this study is to establish a panel data set that could provide sensitive information in the field of transportation planning in Metro Manila; specifically the formulation and evaluation of transport policies and measures (i.e., TSM measures, fare structuring, introduction of new transport modes, etc.).

### 1.2 Overview of Panel Studies

FIGURE 1.1: COMPARISON OF PANEL WAVE 2
HOUSEHOLD ACCEPTANCE

| DUTCH PANEL | 58.45% |
|---|---|
| CARDIFF PANEL | 48.91% |
| PUGET SOUND PANEL | 56.30% |
| METRO MANILA PANEL | 50.11% |

In recent years, more and more panel studies were conducted in developed countries with the hope that these could provide a better alternative in analyzing recurrent travel choice and in assessing changes in travel behavior over time. Among the most notable transport panel studies are: Dutch Mobility Panel (6 months wave interval) in Netherlands, Cardiff Consumer Panel (24 week-period) in U.K., and the Puget Sound Transportation Panel (1 year interval) in the U.S. (E. Murakami and W.T.Watterson, 1990). The Dutch Panel, Cardiff Panel and the Puget Sound Panel had 58.45%, 48.91%, 56.30% household acceptance in the second wave as shown in Figure 1.1. The results of the Metro Manila Panel Survey exhibited almost the same household acceptance rate in Wave 2, 50.11% despite the three year interval. However, on the household member level interviewed the rate was quite low (this would be further elaborated in the next chapter).

This brief review would provide the basis on how panel survey and analysis be introduced and tried in developing countries, notably in Metro Manila. More specifically, a) to determine whether attrition rate in the Metro Manila Panel Survey is at par with those in the developed countries; b) how to describe and interpret the dynamic change that might have occurred on people's socioeconomic characteristics and their influence on their travel behavior and trip decisions; and c) to offer an analytical methodology in studying travel behavior in Metro Manila and in general in developing countries.

1.3    Scope and Limitations

This paper is divided into three parts: the first part examines the features of the conduct of the panel survey in Metro Manila, the third part discusses the preliminary analyses, and the last part presents the findings and conclusions of this study. As such, this paper focuses on: a) how the panel survey was conducted and the difficulties encountered, and b) descriptive analysis of the changes between the waves, analysis, and c) analyzing the modal choice models between the two waves as a means to develop the modeling framework.

## 2.   METRO MANILA PANEL SURVEY
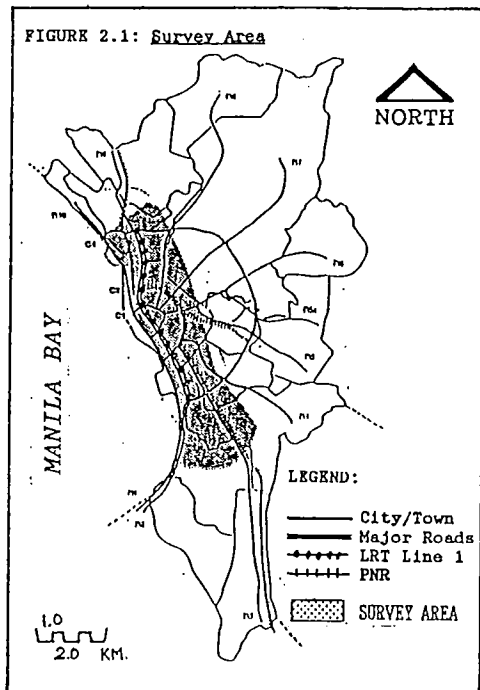
### 2.1  Design of the Survey

Study Area and Composition of Household Samples

The case study for this paper is Metro Manila, the national capital region of the Philippines. It is the country's prime region having an area of 636.0 sq. kms. with a population of 7.80 millions as of last census in 1990 (13.0% of the national population). The major modes of transport in the region are: jeepney (48.4% of overall transport demand in 1989), bus (2.38%), LRT (1.72%), and private modes (35.28%). The LRT system was introduced in 1984 along one of the major corridors of Metro Manila. Future extension of the LRT is currently being planned.

The survey area is shown in Figure 2.1 and is composed of 49 traffic zones, out of the 202 traffic zones in Metro Manila situated along the LRT corridor. It covered all the four cities and one out of the thirteen municipalities in Metro Manila. Close to 412,200 (26.44%) of total households (1,559,000) in Metro Manila reside in the survey area consisting roughly 26.3% of Metro Manila's population. 892 households (0.21% of the survey area's total) from the original survey in January 1987 (first wave) comprised the survey sample size for the second wave (March 1990). These household samples covered in the 1987 survey were selected using the purposive-quota-proportional sampling (i.e., with respect to income distribution and density).



FIGURE 2.1: Survey Area

NORTH

MANILA BAY

LEGEND:
City/Town
Major Roads
LRT Line 1
PNR
SURVEY AREA

1.0
2.0  KM.

### 2.2   Design and Conduct of the Survey

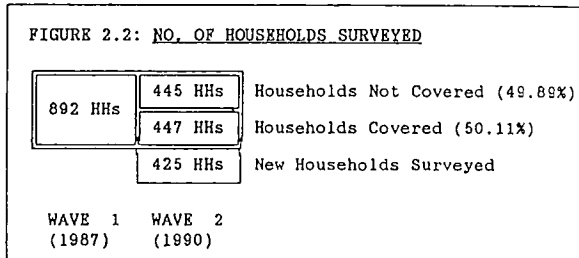In the design of the survey, a list of the households

and their members interviewed in the 1987 survey was prepared and was the targeted sample for the 1990 survey. Likewise, the set of questionnaires used was basically that of the 1987 survey so that the same inquiries would be made. However, slight changes were made: a) in the household information form, telephone number/s were asked, and the length of residence in given address were asked; b) in the member information form, length of employment was asked; and c) the 1990 survey had three forms in contrast to the 1987 survey wherein the third form was the trip information form for household members. In summing up, pertinent socioeconomic, trip and level of service characteristics of samples were asked in both surveys.

The survey was in the form of a personal interview (door-to-door) wherein enumerators visited the household samples and asked the questions and household members supplied the necessary responses. Since the survey was a panel survey, the enumerators first asked the household members on their list and interview them. If those on the list were not around during the first visit, the enumerators would try to make appointments for possible revisit. The survey organization was composed mainly of two survey staff, 16 enumerators and 4 supervisors; most of which were the same enumerators and supervisors hired in the 1987 survey. The survey was from 15:00-21:00 from Monday to Friday and 8:00-17:00 during week-ends to cover as many working members of the households as possible. Each enumerator was allocated 5 households per day to be interviewed so as to give allowable time in locating the households and for interview time.

## 2.3    Results of the Survey

The total number of households covered by the 1990 Survey is 872, with 447 households from the 1987 Survey and 425 new households, Figure 2.2. Figure 2.3 provides a break-down of the Wave 1 households covered in Wave 2. More than half of the households, 50.11%, on the first wave (1987 survey) were covered on the second wave (1990 survey) despite the three-year interval. .

FIGURE 2.2: NO. OF HOUSEHOLDS SURVEYED

| 892 HHs | 445 HHs | Households Not Covered (49.89%) |
|---------|---------|---------------------------------|
|         | 447 HHs | Households Covered (50.11%)     |
|         | 425 HHs | New Households Surveyed         |

WAVE  1      WAVE  2
(1987)      (1990)

The proportion of households remaining in the second

wave is relatively near to that of the Dutch Panel, 58.45% (Golob, et. al, 1986) Cardiff Panel, 48.91% (Wrigley, et. al., 1985) and the Puget Sound Transportation Panel, 56.20% (Murakami and Watterson, 1990) as shown in Figure 1.1.

Table 2.1 gives the main causes of Wave 1 households not participating in the survey in Wave 2 and households whose members interviewed in Wave 1 but not interviewed in Wave 2. The causes of non-participation were quite similar to those identified by Kitamura and Bovy. Those refusing the survey mostly belong to one particular sector and older members of the household.
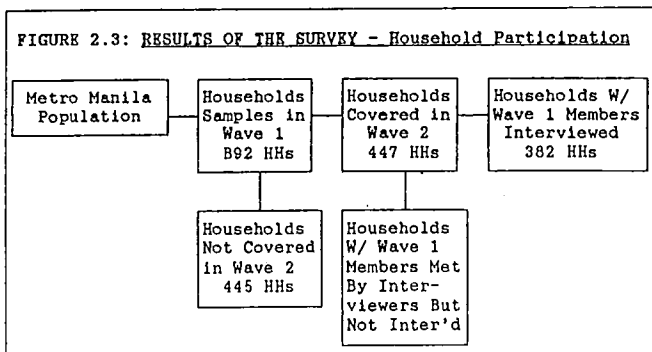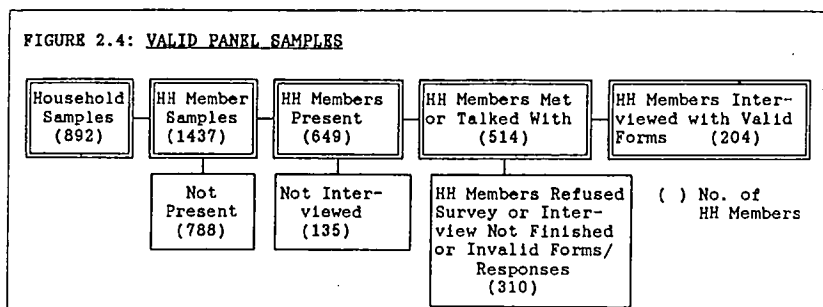
FIGURE 2.3: RESULTS OF THE SURVEY - Household Participation

| Metro Manila Population | Households Samples in Wave 1 B92 HHs | Households Covered in Wave 2 447 HHs | Households W/ Wave 1 Members Interviewed 382 HHs |
|---|---|---|---|

| | Households Not Covered in Wave 2 445 HHs | Households W/ Wave 1 Members Met By Inter- viewers But Not Inter'd | |

TABLE 2.1: CAUSES OF NON-PARTICIPATION

A. HOUSEHOLDS NOT COVERED BY SURVEY

| | | |
|---|---|---|
| Households Transferred Residence | 154 HHs. | ( 34.61%) |
| Households Refusing the Interview | 124 HHs. | ( 27.86%) |
| Households Could Not be Located | 116 HHs. | ( 26.07%) |
| Households Not in Given Address | 51 HHs. | ( 11.46%) |
| TOTAL | 445 HHs. | (100.00%) |

B. HOUSEHOLDS COVERED BUT WAVE 1 MEMBERS NOT INTERVIEWED

| | | |
|---|---|---|
| Households with Wave 1 Household Head Not Interviewed in Wave 2 | 22 HHs. | ( 33.85%) |
| Households with Wave 1 Members Went Abroad | 14 HHs. | ( 21.54%) |
| Households with Wave 1 Members Out of Town or to the Province | 9 HHs. | ( 13.85%) |
| Households with Wave 1 Members Moved out of the Household | 8 HHs. | ( 12.31%) |
| Households with Wave 1 Members Deceased | 3 HHs. | ( 4.60%) |
| No Reasons Mentioned | 9 HHs. | ( 13.B5%) |
| TOTAL | 65 HHs. | (100.00%) |

Figure 2.4 exhibits the household members that constituted the final samples, 204 members, for this study. Although there were 514 Wave 1 members approached, 310 either refused to be interviewed again or the interview was not finished. Nevertheless, other members of the panel households who were not interviewed in Wave 1 were interviewed as possible replacements.

FIGURE 2.4: VALID PANEL SAMPLES

| Household Samples (892) | HH Member Samples (1437) | HH Members Present (649) | HH Members Met or Talked With (514) | HH Members Interviewed with Valid Forms (204) |
|---|---|---|---|---|
| | | Not Present (788) | Not Interviewed (135) | HH Members Refused Survey or Interview Not Finished or Invalid Forms/ Responses (310) | ( ) No. of HH Members |

This observation on household level participation in the panel survey indicates that attempting to conduct a panel survey in a developing country is comparably probable.

3. DESCRIPTIVE ANALYSIS

In this chapter, changes in the socioeconomic characteristics, over the three-year period, of the 204 panel member samples, Figure 2.4, are analytical described. Of particular interest among the socioeconomic characteristics of the panel samples to be described in this paper are employment and work place. These attribute seem to have most dynamic change among the socioeconomic characteristics.

Of the 204 panel members who were employed in Wave 1, 32 (15.69%) were no longer employed in Wave 2; and out of these unemployed members, ten reverted to plain housewives (4.9%). The percentage of panel members holding the same jobs for both waves is 36.76% (75 members). This observation reflects the movement from one occupation to another which could have been as a result of the mobility in the employment sector that occurred over the three-year gap between the two waves. One impact of these changes could be on the change of head of households (defined here as main breadwinner for the household) between the two waves, 22 households (4.92%) of the total households in the two waves.

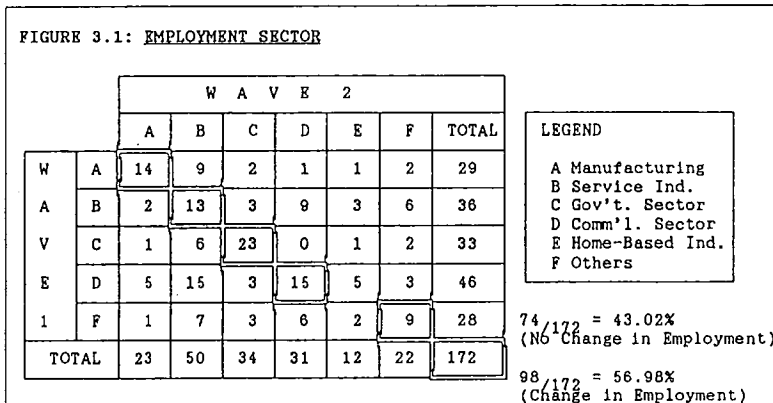Figure 3.1 shows that almost 57% of employed panel

members have changed employment. Considering the three-year gap, this phenomenon represents a dynamic change. The industry that showed most of panel members moving out is the commercial sector (73.91%). An absorbing observation is the entry of Home-based industry which was not present in Wave 1. Several external factors could have influenced these dynamic variations; during the three-year period between the two waves, socio-economic and political transformation had occurred in Metro Manila, and in general the country. A change of government, for instance, could have influence this occurrence; there has been a rapid growth of the underground economy in the region contributing to the increase of people engaging in home-based industries.

The shift of employment has also affected the monthly income of household members. There was a horizontal increase in income although almost 42% showed no change in their monthly income between the two waves. However, 31% have shown a decrease in their income.
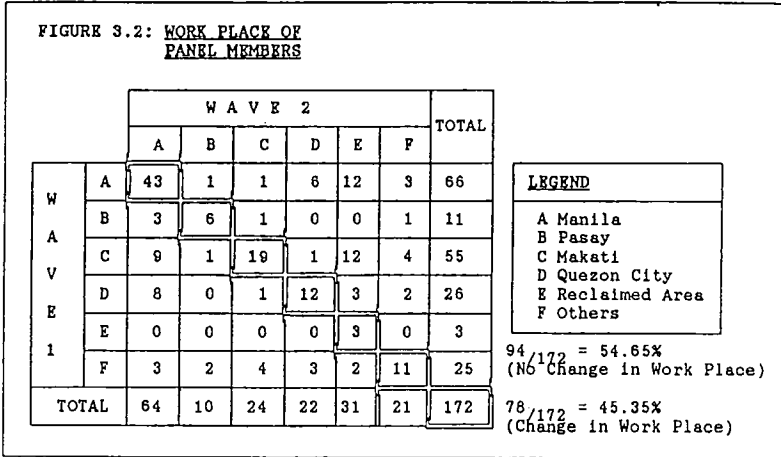
These observations clearly indicate that any change or movement in one particular socioeconomic characteristics greatly affects the other characteristics of people.

To look if these changes and movements have effects on people's travel behavior, the work place changes between the two waves would be described first and a more analytical approach would be in the next section. For this purpose, work place of the 172 household members between Wave 1 and Wave 2 will be described as shown in Figure 3.4

Since the figures represent same samples between the two waves, it could be contemplated that the shifting of work place is influenced by the change of employment. This is particularly evident on the decline of panel members working in Makati, the prime business district of Metro Manila, and the increase of panel members working in the reclaimed area along Manila Bay (which has shown some land-use change in the past years).

FIGURE 3.1: EMPLOYMENT SECTOR

| | | W A V E 2 | | | | | | | LEGEND |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | TOTAL | |
| W | A | 14 | 9 | 2 | 1 | 1 | 2 | 29 | A Manufacturing |
| A | B | 2 | 13 | 3 | 9 | 3 | 6 | 36 | B Service Ind. / C Gov't. Sector |
| V | C | 1 | 6 | 23 | 0 | 1 | 2 | 33 | D Comm'l. Sector |
| E | D | 5 | 15 | 3 | 15 | 5 | 3 | 46 | E Home-Based Ind. |
| 1 | F | 1 | 7 | 3 | 6 | 2 | 9 | 28 | F Others |
| | TOTAL | 23 | 50 | 34 | 31 | 12 | 22 | 172 | |

$74/172 = 43.02\%$ (No Change in Employment)

$98/172 = 56.98\%$ (Change in Employment)

From these descriptions of the changes in the socioeconomic characteristics of panel members it could therefore be surmised that by observing a particular sample over two or more points in time, even in a developing country, could provide a better outlook of the changes that occurred.

FIGURE 3.2: WORK PLACE OF
PANEL MEMBERS

| | | W A V E 2 | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | |
| W A V E 1 | A | 43 | 1 | 1 | 6 | 12 | 3 | 66 |
| | B | 3 | 6 | 1 | 0 | 0 | 1 | 11 |
| | C | 9 | 1 | 19 | 1 | 12 | 4 | 55 |
| | D | 8 | 0 | 1 | 12 | 3 | 2 | 26 |
| | E | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| | F | 3 | 2 | 4 | 3 | 2 | 11 | 25 |
| TOTAL | | 64 | 10 | 24 | 22 | 31 | 21 | 172 |

LEGEND

A Manila
B Pasay
C Makati
D Quezon City
E Reclaimed Area
F Others

$94/172 = 54.65\%$
(No Change in Work Place)

$78/172 = 45.35\%$
(Change in Work Place)

4.    ANALYSIS OF MODE-CHOICE "TO WORK TRIP'

The number of panel samples having valid "To Work Trips" in Wave 2 is 141. In this regards, this study would use the total samples for both waves (Wave 1- 860 and Wave 2-644) in comparing the mode-choice models. These samples could be considered as *pseudo panel* since they also include all panel households and in the same survey area.

The variation in actual mode to work of the 141 panel samples is shown in Figure 4.1. Although the sample is quite small, the mode shift reveals the influence of the movement in employment and work place as shown by the change of mode of more than 43%.

The decline of people using LRT in going to work, in this particular case, could be attributed to the decline in panel samples working in areas situated along the LRT corridor. One specific example is Makati, which is accessible to LRT, the reduction in panel members working in this prime town could have shown a reduction in LRT users in Wave 2. This could be attributed to the decline in panel members employed in the commercial sector since Makati is a leading commercial center in Metro Manila.

The models for the two waves were calibrated using disaggregate multinomial logit modeling. The mode choice set is consist of four alternative modes: Jeepney (a paratransit mode), Bus, LRT and Car. The mode car is defined as private modes of transport excluding tricycles and the like. The relevant variables employed in estimating the models

FIGURE 4.1: ACTUAL MODE TO WORK

| | | W A V E 2 | | | | |
|---|---|---|---|---|---|---|
| | | JEEPNEY | BUS | LRT | CAR | TOTAL |
| W A V E 1 | JEEPNEY | 52 | 9 | 6 | 12 | 79 |
| | BUS | 8 | 7 | 1 | 1 | 17 |
| | LRT | 13 | 2 | 11 | 5 | 31 |
| | CAR | 5 | 0 | 0 | 9 | 14 |
| | TOTAL | 78 | 18 | 18 | 27 | 141 |

$79/141$ = 56.03% : No Change in Mode

$62/141$ = 43.97% : Change in Mode

are shown in Table 4.1. Of the three LOS variables, two are generic (OVTT and IVTT) while the other one is specific to car (TOC). On the other hand, all the S-E variables are specific to car. The LOS data for both waves were generated on street level. A study by Villaroman (1988) found that LOS data generated on street level were found to be more precise in estimating multinomial logit models. The results of the estimation of disaggregate models are summarized in Table 4.2.

TABLE 4.1: VARIABLES FOR MODELING

Level of Service Variables (LOS)

Out-Of-Vehicle Travel Time (OVTT)
In-Vehicle Travel Time (IVTT)
Total Operating Cost

Socioeconomic Variables (S-E)

Member Income (INC)
Member License-Held (LIC)

Constant Variables (CON)

Jeepney-Constant (JCONST)
Bus-Constant (BCONST)
LRT-Constant (LCONST)

The results given in Table 4.2 yield the following: a) the values of $\rho^2$ and HIT are high implying that the data provide good estimation; b) t- values of the parameters, except Wave1 Model's TOC and Wave2 Model's INC and JCONST, are acceptable at 5% significance level; c) the signs of the parameters for both models are the same and have good fitness; and d) except for TOC, INC, JCONST and LCONST the parameters are statistically indifferent. The t-test statistic for each parameter was calculated using the formula below:

$$t=|\beta_1-\beta_2|/\left(s\sqrt{(1/n_1+1/n_2)}\right)$$

where:

$$s=\sqrt{\{(n_1-1)\,n_1\sigma_1^2+(n_2-1)\,n_2\sigma_2^2\}/\,(n_1+n_2-2)}$$

$\beta_1$, $\beta_2$ = Estimation Parameters of Models 1 and 2
$n_1$, $n_2$ = Sample Sizes of Models 1 and 2
$\sigma_1^2$, $\sigma_2^2$ = Variances of Estimation Parameters of Models 1 and 2

The results of the t-test statistics are given in Table 4.3.

The findings of this analysis yield the following: a) modal choice models' estimation parameters are not stable; b) further analysis is needed to identify the causes of instability, however, it can be inferred that total operating costs and member income are not stable over the three year interval; and c) these instability could be a result in the fluctuation of fuel prices and economic changes. Therefore it could be surmised that: a) the change in modes are the effects of the movements in work places which in turn was influenced by change of employment; and b) the visible impact of the changes in modes is on trip or O-D pattern of people in Metro Manila.

TABLE 4.2: COMPARISON OF MODELS

| | | Wave 1 Model | | Wave 2 Model | |
|---|---|---|---|---|---|
| | | $\widetilde{\theta}$ | t-value | $\widetilde{\theta}$ | t-value |
| L | OVTT (G) | -0.1863 | -3.76 | -0.1389 | -2.40 |
| O | IVTT (G) | -0.0148 | -2.58 | -0.0240 | -4.03 |
| S | TOC (S) | -0.0066 | -0.73* | -0.0489 | -2.94 |
| S | INC (S) | 0.0089 | 3.25 | 0.0014 | 0.85* |
| E | LIC (S) | 1.1678 | 3.27 | 1.7064 | 4.54 |
| C | J CONST | 2.2379 | 5.52 | 0.0858 | 0.23* |
| O | B CONST | 1.1203 | 2.56 | 1.3265 | 3.16 |
| N | L CONST | 2.8030 | 6.00 | 0.8216 | 1.85 |
| D.F. | | 8 | | 8 | |
| $\chi^2$ | | 351 | | 315 | |
| L($\widehat{\theta}$) | | -631.9574 | | -468.6959 | |
| $\rho^2$ | | 0.2129 | | 0.2463 | |
| HIT | | 64.2 | | 68.0 | |
| SAMPLES | | 860 | | 644 | |

TABLE 4.3: t-Test Results

| Parameter | t-Value |
|---|---|
| OVTT | 0.6239 |
| IVTT | 1.0971 |
| TOC | 2.3857** |
| INC | 19.3592** |
| LIC | 1.0261 |
| JCONST | 3.6702** |
| BCONST | 0.3299 |
| LCONST | 2.9878** |

** Significant at 5% Significance Level

LEGEND: (G) = Generic
(S) = Specific to Car

*not significant at 5% Significance Level

## 5.   SUMMARY OF CONCLUSION

To summarize this paper, three main points were discussed: a) panel survey design, b) effectiveness of panel data, and c) usefulness of such data for transport planning.   It  was found that at the household level conducting panel survey pose no problems; however, much is still needed to ensure the increase of household member participation and also those in the higher income level and Chinese households who refused in Wave 2.   To do this necessary measures must be instituted in succeeding waves. Among these measures are: a) notifying panel households of the survey before the conduct of the survey; b) augmenting the number of households in the group that refused the survey; c) implementing an effective way of checking and monitoring of survey (i.e., telephone checking); and d) employing experienced enumerators.

It was ascertained that utilizing panel data provide a more dynamic characterization of the changes in socio-economic and travel behavior of people over time.   The unstable economic and political peculiarities in the developing countries influence people's travel behavior and trip decision making.   This was demonstrated by the movements in employment sector and work places of the panel sample members.   This could have been influenced by the growth in the shadow (underground) economy in Metro Manila.   These shifts in employment impelled the movements in work places as shown by more than 45% of the panel samples.   The obvious result of this is the influence on the  O-D  patterns,  change  of  mode  by  the  and  the instability of mode choice structure, to some extent.

Finally, in the field of urban transportation planning in developing  countries,  such  as  in  Metro Manila  for instance,  the  prospect  of  introducing  panel data  and analysis of these data provides a more responsive and sensitive approach in formulating and evaluating transport policies  and  measures  and  transport  planning  schemes. That is, by observing the pattern of change in the socioeconomic  and  trip  characteristics  of ˙the  same individuals, travel behavior and trip decisions could be better understood.   This would be beneficial in making short-term  transportation  planning  more  effective  and susceptible.

Therefore,  in  concluding  this  paper,  despite  the limitations and constraints of  this  initial attempt of introducing panel analysis and survey in Metro Manila, they are indeed vital tools for studying travel behavior even in developing countries.   To ensure a more productive panel survey design in developing countries, appropriate and necessary measures such as those mentioned must be

instituted before any panel surveys will be conducted.

Hence, the next tasks for this study are: a) to institutionalize the conduct of transport panel survey by adopting logical and feasible measures on how to minimize attrition in future waves; and b) to further analyze the various dynamic changes in the travel behavior of the panel members and more specifically to determine the collinearity of the panel data in Metro Manila and the causes of the instability of parameters. That is, to further determine what is the dynamism of travel behavior in the developing countries and to develop more appropriate methodology needed in introducing panel analysis in the field of transportation planning in those regions.

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