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THE EFFECTS OF PERCEPTION AND FEELING VARIABLES ON MODE-CHOICE BEHAVIOR IN METRO MANILA

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This paper aims to describe the effects of subjective variables on mode-choice behavior in Metro Manila. The findings of this study are: a) objective explanatory variables are more powerful than subjective ones, b) more precisely measured LOS variables could yield better model estimate, and c) disaggregate logit model is quite powerful in explaining mode choice behavior not only in the developed countries but also in developing nations.

1. INTRODUCTION

It is generally conceived that because of the influence of the wide disparity between the rich and the poor, people in developing countries tend to be more conscious of their economic status which affects travel decision-making than in developed countries. This leads to the assumption that not only socioeconomic (SE) variables like income, occupation and car ownership play an important role in travel mode choice behavior but also the people's way of thinking and attitudes toward various transport modes, which further leads to the presumption that socioeconomic and attitudinal variables have bigger effects than in developed countries.

While studies on subjective and attitudinal modeling of travel behavior have been undertaken in developed countries, e.g. Lovelock (1975), Gilbert and Foerster (1976), Golob, et. al (1979), Dobson and Tischer (1977), Hensher and Stopher (1979), Koppelman and Pas (1977), Kroes and Sheldon (1985), Louviere, et. al. (1981) and Satoh and Igarashi (1986) with varied results, there are only a few studies for developing countries. In the Malaysian Model (Kurokawa, et.al. (1986) and the Indian Model (Sinha, et. al. (1989)) for example, significant variables were mostly socioeconomic variables. However, we must note that in these studies, level of service (LOS) variables were measured based on traffic zone scheme, and the degree of measurement accuracy was not high. If the general perception regarding people's irrationality in developing countries is right, this implies the subjectivity in choice behavior of people in these countries.

The objectives of this study are first, to examine the effects of accuracy of LOS variables on parameter estimates, second, to explore the relationships between attitudinal and subjective variables and objectively measured LOS variables and SE variables, thirdly, to describe the effects of subjective variables on work trip mode choice behavior, and finally, to examine the adaptability of the *'Hybrid Model'* to Metro Manila. The Hybrid Model is defined as a disaggregate

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model which carries objective and subjective variables simultaneously. These subjective variables are divided into two groups: perceptions of attributes of transport modes and feelings of individuals toward each particular mode. Perception variables consist of expressions of how an individual perceives or understands the service characteristics of modes, such as speed, cheapness, safety, etc.. On the other hand, feeling variables are impressions of modes which are supposed to be influenced by the cultural and personal values of the individual.

The case study area is Metro Manila, the National Capital Region of the Philippines. It is a primate metropolitan area and is the most thickly populated region with a total population of 6.05 million in 1983 and growing at an average rate of 3.6%. The average population density per sq. km. is 9,000, varying from 3,000 to 48,000. The mode choice behavior for work trip in this region is a choice among jeepney, bus, Light Rail Transit (LRT) and car. Jeepney has the biggest share of 54.5%, car and jeep capture 15.9% and bus has a 15.8% share (JUMSUT, 1984). The LRT was opened in 1984 and has rapidly gained patronage at 330,000 trips per day.

2. SURVEY DESIGN AND QUESTIONNAIRE

To achieve the objectives, a home interview survey (HIS) was conducted in Metro Manila. A total of eight-hundred sixty (860) work trip samples were gathered wherein the origin, destination and transfer points of individuals were exactly identified. This HIS includes individual information survey (age, sex, income, occupation,etc.), work trip information survey (residence address, office address, transportation mode chosen, transfer points, departure and arrival time, etc.) and mode preference survey. The latter consists of ten perception questions and attributes of four major modes (jeepney, bus, LRT and car) and four feeling questions for each of the four major modes (Table 2-1). Work trip information was processed on two different precision levels. Zonal LOS data were measured based on the existing 202 traffic zone system (average zone sizes in terms of area and population are 314 has. and 37 thousand respectively; whereas, Street LOS data were based on street level of precision.

Table 2-1
Perception and Feeling Questions

Perception
1 Fast(FAST)
2 Cheep(CHEAP)
3 Safe from pickpokets(SAFEP)
4 seats available(SEAT)
5 Available when needed(AVAIL)
6 Music available(MUSIC)
7 Can talk with friends(TALK)
8 Safe from accidents(SAFEA)
9 Not tiresome(TIRE)
10 Direct route(DIR)
Feeling
1 enjoy travel(ENJOY)
2 ought to travel(OUGHT)
3 travel regardless of cost(MONEY)
4 travel regardless of time(TIME)

For the purpose of reducing interviewees burden and getting more correct responses, three presurveys were conducted in 1983, 1984 and 1986. Factor analysis was employed to know the underlying structure of feelings and perceptions on the four major transport modes and also to reduce the number of questions to the more important ones only.

3. 1987 MODE PREFERENCE SURVEY

3.1 Profiles of Perceptions and Feelings

The 1987 Mode Preference Survey includes 10 perception and 4 feeling variables translated into *'Tagalog'* (the native language of the study area). Fig. 3-1 shows the mapping of average standardized perception ratings. Car is rated the fastest followed by LRT, then by jeepney and lastly by bus. Car is rated the least cheap and jeepney is the cheapest which is consistent with our objectively measured cost. Generally, car is rated the most positively in terms of *'safe from pickpockets'*, *'seats available'*, *'available when needed'*, *'safe from accidents'* and *'direct route'*. LRT is rated second for *'safe from pickpockets '*, *'available when needed'*, *'safe from*

Fig. 3-1 Average Perceived Attritutes Ratings

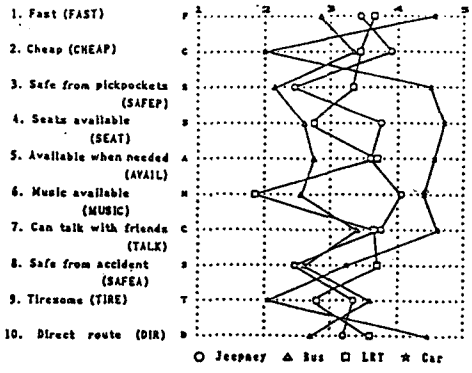


Fig. 3-2 Average Feeling Ratings

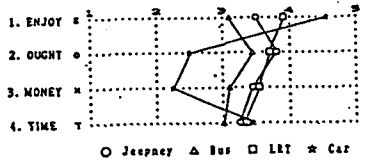
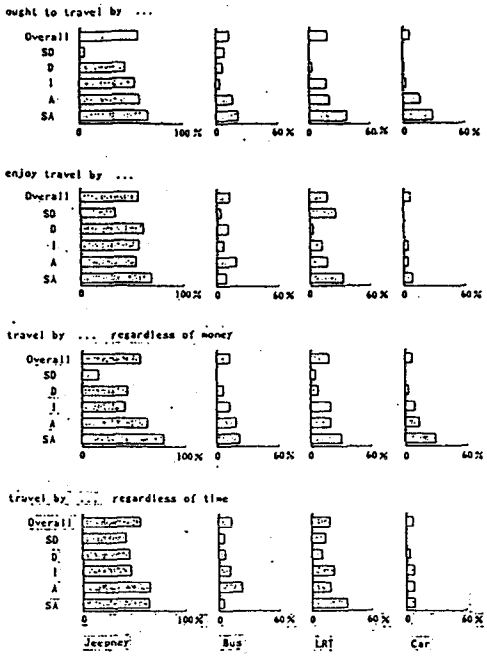


Fig. 3-3 Mode Share by Response to Feeling Questions



accidents' and *'direct route'*. Jeepney is rated second for *'cheap'*, *'seat available'*, *'music available'*, and *'can talk with friends'*. Bus is rated first for *'tiresome'*, and is generally rated negatively.

Fig. 3-2 shows the mapping of average standardized scores for feeling variables. Results demonstrate that people in Metro Manila generally *'enjoy travel (or would enjoy travel)'* by car followed by LRT, by jeepney and the least by bus. Most people think that they *'ought to travel by public transit rather than by car'* and they are generally aware that travel by car entails more cost than traveling by public transit and, to a lesser extent, *'time spent'* is also being considered.

The above results seem to be realistic considering the existing situation of transportation and the people's way of thinking profiles only show the *'average'* perceptions and feelings. In order to know the underlying structure of perceptions and feelings and to know their importance in mode choice behavior, the relationships among perception and feeling variables, objectively measured LOS and SE characteristics were examined.

3.2 Effects of Feelings on Mode Choice

Figure 3-3 shows the relationship between feeling variables and mode choice. There is the tendency that as the degree of agreement to a certain question increases, the mode share in the group becomes higher. For example, regarding *'ought to travel by car'*, the *'strongly agree'* group has car share of 34.3% whereas car share in the *'strongly disagree'* group is only 0.6% and overall car share is 0.8%

This tendency is common to all the four modes and all the four feeling variables, especially *'ought to travel'* and *'regardless of money'* have quite clear and monotonous relationship. Since the analysis cited here are based on aggregate data, we may conclude that feelings toward transport mode collectively affect mode choice. However, nothing is mentioned about the

behavioral aspect of perception and feeling. This is done in the next two sections.

3.3 Perception Ratings and Level of Service

The origin, destination, transfer points and chosen modes can be pinpointed from the work trip information survey and hence, level of service of the chosen modes can be calculated. Pearsonian correlation was computed between objectively measured LOS variables [fare (FARE), in-vehicle travel time (IVTT), walking time (WKT), out-of-vehicle travel time (OVTT), and number of transfers (NOT)] and perception ratings for each mode. Cramer's V was computed between socioeconomic characteristics [occupation (OCCP) and income (INC) and perception ratings.

Table 3-1 shows the results. First of all, one will notice that sign conditions are not met for a number of pairs; for example, 'FARE and CHEAP' has a correct sign for jeepney, but incorrect for bus, LRT and car. Although values of correlation coefficients are small, many of them are significant at high level. This is attributable to the large number of samples.

3.4 Feelings and Socioeconomic Characteristics

Cramer's V was computed between the four feeling variables and selected socioeconomic variables and the results are shown in Table 3-2. Income has the highest correlation with the car-*'OUGHT'* and show changes in feeling as income changes. As income increases, the portion of *'disagree to ought to travel by jeepney'* increases rapidly, and the portion of *'agree to ought to travel by car'* increases too. Thus, the relationships between income and *'ought to travel'* are quite clear, and are not so distinct for bus and LRT.

The above analysis, together the results of section 3.2 that *'OUGHT'* affects mode choice, show the possibility that income can play an important role in explaining people's mode choice behavior as a substitute for feeling variables.

Table 3-1 Correlation of LOS, SE and Perception Variables

	1 FAST	2 CHEAP	3 SAFEP	4 SEAT	5 AVAIL	6 MUSIC	7 TALK	8 SAFEA	9 TIRE	10 DIR
JEEPNY										
1 FARE	-.11**	-.06	-.04	.01	-.01	-.01	-.02	-.01	.04	-.09*
2 IVTT	-.11**	-.17**	-.03	.06	-.03	.01	.07*	.05	.04	-.06
3 WKT	-.01	.02	-.03	-.10**	-.12**	-.08*	.04	-.06	.04	-.02
4 OVTT	.04	-.03	-.05	.00	-.01	.01	.00	.07*	-.09*	.03
5 NOT	-.11**	-.12**	-.01	.01	-.08*	-.03	.03	.02	.00	-.12**
6 OCCP	.07	.08	.09	.07	.09	.08	.09	.07	.08	.08
7 INC	.11**	.07	.10*	.06	.09*	.09	.09	.08	.08	.05
BUS										
1 FARE	.08*	.09*	.00	.02	.01	-.05	.00	.01	-.03	-.05
2 IVTT	.11**	.04	.07*	.13**	.12**	.02	.04	.05	-.02	.12**
3 WKT	.03	.06	.00	.00	.03	-.05	.04	.02	-.04	.03
4 OVTT	.00	.06	.05	.03	.07*	.06	-.01	.03	.02	.02
5 NOT	.01	.04	-.04	.03	.03	.02	.01	-.03	.00	.05
6 OCCP	.10*	.06	.08	.07	.07	.07	.06	.09	.08	.08
7 INC	.08*	.08	.12**	.08	.10*	.07	.08	.09	.07	.08
LRT										
1 FARE	.22**	.13**	.08*	.03	.10**	-.03	.07*	.07*	.09*	.09*
2 IVTT	.20**	.15**	.07*	.03	.10**	.00	.05	.06	.09*	.10**
3 WKT	.24**	.11**	.11**	.03	.09*	.02	.09*	.07*	.09*	.13**
4 OVTT	.19**	.12**	.07*	.00	.10**	-.02	.07*	.02	.09*	.08*
5 NOT	.13**	.09*	.02	.00	.05	.00	.06	.06	.06	.05
6 OCCP	.10*	.10*	.06	.06	.08	.08	.07	.08	.04	.06
7 INC	.14**	.09	.09	.08	.10*	.08	.06	.10*	.09	.08
CAR										
1 FARE	.06	.02	.09*	.13**	.10**	.10**	-.02	.08*	-.05	.14**
2 IVTT	.05	.02	.09*	.13**	.10**	.10**	-.02	.08*	-.05	.14**
3 OCCP	.07	.06	.06	.06	.10*	.11*	.07	.11*		
4 INC	.07	.09	.10*	.08	.08	.11*	.08	.08		

* significant at 10%
** significant at 1%

Fig. 3-4 'OUGHT' Feeling by Income

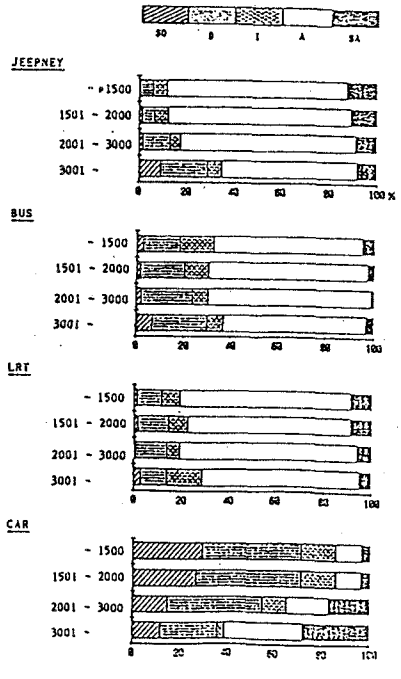


Table 3-2 Correlation of Some Selected Soci-Economic and Feeling Variables

		1 ENJOY	2 OUGHT	3 MONEY	4 TIME
JEEPNEY	OCCP	.08	.10*	.10*	.09
	INC	.07	.16**	.10*	.13**
BUS	OCCP	.10*	.10*	.09	.06
	INC	.10*	.10*	.08	.10*
LRT	OCCP	.03	.04	.07	.04
	INC	.11**	.08	.06	.06
CAR	OCCP	.06	.20**	.13**	.09
	INC	.11*	.23**	.21**	.11*

* significant at 10%
**significant at 1%

4. THE *'HYBRID LOGIT MODEL'*

To examine the exploratory power of the subjective variables in actual mode choice context, we developed the *'Hybrid Logit Model (HLM)'* as well as the *'Ordinary Logit Model (OLM)'*. The Hybrid Logit Model is defined as a disaggregate logit model which carries objective and subjective variables simultaneously to reduce the unknown random components, whereas, the Ordinary Logit Model includes only the objective variables.

In this paper, the Hybrid Logit Model includes four types of independent variables: 1) objectively measured (by the analyst) attributes of alternatives, 2) subjectively perceived (by the traveler) attributes of alternatives, 3) feelings (of the traveler) toward alternatives and 4) the socioeconomic characteristics of the traveler. From this idea of the Hybrid Model, the individual utility function (assumed linear in parameters) can, therefore, be defined as:

$$U_{ij} = [A^m_{ij},\ X_{ij},\ S^m_{ij},\ F_{ij}]\ \theta + \eta_{ij} \qquad (4.1)$$

where: A^m_{ij} = vector of measure attributes of mode j for individual i
X_{ij} = vector of perceived attributes of mode j by individual i
S^m_{ij} = vector of SE characteristics of individual i choosing mode j
F_{ij} = vector of feeling ratings on mode j by individual i
θ = vector of parameters
η_{ij} = random portion of individual i's utility for mode j

The X_{ij}'s and F_{ij}'s are assumed to enter the individual utility function indirectly because these variables are unobservable. However, we can list down indicators denoted as A_{ij} and S_{ij} which represents the vector of perceptions and feelings, respectively. These indicators may be 'raw' variables or factor scores if factor analysis suits one's purpose, like safety, reliability, availability, etc.. Thus, the following relationships are assumed to hold:

$$A_{ij} = f(X_{ij}) + \varepsilon_{ij} \qquad (4.2)$$
$$S_{ij} = g(F_{ij}) + \zeta_{ij} \qquad (4.3)$$

Substituting these relationships into Eqtn. (4.1), we get:

$$U_{ij} = [A^m_{ij},\ A_{ij},\ S^m_{ij},]\ \theta' + \eta'_{ij} \qquad (4.4)$$
$$= V[A^m_{ij},\ A_{ij},\ S^m_{ij},\ S_{ij}] + \eta'_{ij}$$

and the Hybrid Logit Model can be defined formally as :

$$P_{ij} = \frac{\exp[V(A^m_{ij},\ A_{ij},\ S^m_{ij},\ S_{ij})]}{\sum_{k \in C_i} \exp[V(A^m_{ik},\ A_{ik},\ S^m_{ik},\ S_{ik})]} \qquad (4.5)$$

where: P_{ij} = probability that individual i will choose mode j
C_i = choice set of individual i

5. MODELING AND ANALYSIS

5.1 Effects of Data Accuracy on Parameter Estimates

Table 5.1 shows the effects of two different LOS measurement accuracies; one has zonal level of accuracy [87(Z)], the other has street level [87(S)]. The effects of accuracy of data are: a) street data tend to give more significant LOS parameters, IVTT and FARES, b) relative ratios of two parameter estimates such as IVTT and FARE, IVTT and OVTT are better in 87(S) than in 87(Z), judging from existing research results, and c) the ρ^2 of 87(S) is almost two times better and the % HIT is about 1.2 times better than 87(Z). These effects show that more precisely measured LOS could give higher goodness-of-fit, more significant LOS variables for policy analysis, and hence, could improve logit models very much.

Table 5.1 Effects of Differences in Data Accuracy, on Model Estimates

	VARS	'87(S)	'87(Z)
LOS	NOT(SG)	-0.7891 (-5.23)	-0.7113 (-6.38)
	OVTT(SG)	-0.2886 (-3.98)	-0.1621 (-3.32)
	WKT(SG)	-0.0140 (-1.61)	-0.0689 (-1.71)
	IVTT(G)	-0.0549 (-3.00)	-0.0044 (-0.76)
	FARE(G)	-0.0125 (-1.09)	0.0002 (0.03)
S-E	JORIG	1.0970 (2.68)	0.4250 (2.19)
	CHINC	0.9629 (0.23)	0.5386 (1.42)
	CILIC	2.1266 (5.20)	1.4742 (3.34)
CON	JCON	2.2365 (3.43)	0.1434 (0.28)
	BCON	3.2007 (5.84)	-0.8561 (-1.66)
	LCON	5.4155 (8.66)	0.7691 (1.44)
STAT	D.F.	11	11
	$\bar{\rho}^2$	1098	657
	L($\vec{\beta}$)	-405.8660	-626.0745
	$\bar{\rho}^2$	0.5713	0.3388
%HIT	JEEPNEY	87.6	84.3
	BUS	32.0	3.9
	LRT	96.9	66.8
	CAR	51.9	41.8
	TOTAL	78.4	65.6
	SAMPLES	860	860

(t-value); (S): street data; (Z): zonal data: (SG): semi-generic; (G): generic

5.2 FRAMEWORK OF MODEL COMPARISON

The general 'state-of-the-art' in disaggregate modeling and the position the Hybrid Model occupies can be represented in Table 5-2. Existing disaggregate models can be grouped into two: a) those models whose dependent variables are stated preferences, b) those whose dependent variables are revealed preferences. Independent variables can also be divided into two groups: a) subjective variables and b) objective variables. The Hybrid Model as defined earlier falls into a third new group of models- with both subjective and objective independent variables.

Table 5-2 Types of Disaggregate Choice Models; Their Forms and Interrelationships

Subjective (Perceptions and Feelings)	Model 1 $P_{ij} = \frac{\exp(V(A_{ij}, S_{ij}))}{\sum_{k=1}^{I} \exp(V(A_{ik}, S_{ik}))}$
Objective (LOS and S-E)	Model 2 $P_{ij} = \frac{\exp(V(A^T_{ij}, S^T_{ij}))}{\sum_{k=1}^{I} \exp(V(A^T_{ik}, S^T_{ik}))}$
Subjective and Objective	Model 3 $P_{ij} = \frac{\exp(V(A^T_{ij}, A_{ij}, S^T_{ij}, S_{ij}))}{\sum_{k=1}^{I} \exp(V(A^T_{ik}, A_{ik}, S^T_{ik}, S_{ik}))}$

P_{ij} is the revealed preference or simply actual choice.

$A^T_{ij}, A_{ij}, S^T_{ij}$, and S_{ij} are as defined in equation 4.1

Comparison between Model 1 and Model 2 gives differences of the explanatory powers of objective and subjective variables. Effects of introducing objective variables into Model 1 comes from comparison between Model 1 and Model 3. By comparing Models 2 and 3, we would know the effects of introducing feeling and perception variables into Model 2.

5.3 Findings of Model Comparison

Model 1 Vs. Model 2

Table 5-3. Model 1 vs. Model 2 (Subjective vs. Objective)/ Model 1 vs. Model 3 (Effect of Objective Vars)/ Model 2 vs. Model 3 (Effect of Subjective Vars)

	VARS	MODEL 1	MODEL 2	MODEL 3
LOS	FARE (G)		-0.0520 (-3.69)	-0.0493 (-3.56)
	JVTT (G)		-0.0114 (-1.62)	-0.0117 (-1.66)
	WKT (SG)		-0.0619 (-3.13)	-0.0632 (-3.18)
	OVTT (SG)		-0.2103 (-3.40)	-0.2061 (-3.43)
	NOT (SG)		-0.6780 (-4.72)	-0.6744 (-4.69)
PERCEPTION	FAST	-0.0242 (-0.33)		-0.0170 (-0.20)
	CHEAP	0.0382 (0.48)		0.0730 (0.80)
	SAFER	-0.0090 (-0.12)		0.1482 (-1.69)
	SEAT	0.0197 (0.26)		0.0426 (0.52)
	AVAIL	-0.0181 (-0.23)		-0.0432 (-0.50)
	MUSIC	0.0802 (1.06)		0.0730 (1.05)
	TALK	0.0721 (0.83)		0.0195 (0.20)
	SAFEA	0.0288 (0.21)		-0.0924 (-0.92)
	TIRE	0.0560 (0.83)		0.0367 (0.48)
	DIR	-0.0316 (-0.19)		-0.0851 (-1.03)
FEELING	ENJOY	-0.0197 (-0.24)		0.0183 (0.20)
	OUGHT	-0.0802 (0.96)		-0.0583 (-0.60)
	MONEY	0.0223 (0.28)		-0.0382 (-0.43)
	TIME	0.0452 (0.60)		-0.0533 (0.62)
S-E	JORIG		0.6477 (3.53)	0.6674 (3.59)
	CHINC		0.8111 (6.42)	0.7921 (5.68)
	CILIC		1.0267 (2.00)	1.0745 (2.05)
CON	JCON	0.4232 (1.30)	3.2551 (5.45)	2.8875 (4.25)
	BCON	-0.8442 (-2.30)	2.3834 (3.90)	2.2228 (3.28)
	LCON	0.7550 (-2.25)	4.3851 (6.68)	4.4035 (6.06)
STAT	D.F.	17	11	25
	$\bar{\rho}^2$	487.5156	669.0581	677.3335
	L($\vec{\beta}$)	-573.7085	-482.9373	-478.7996
	$\bar{\rho}^2$	0.2881	0.4038	0.4019

(t-value) (SG):semi-generic (G):generic

Table 5-3 shows the subjective model (Model 1), the objective model (Model 2) and the hybrid model (Model 3). Model 1 gives low $\bar{\rho}^2$ and contains insignificant variables except for MUSIC. On the other hand, Model 2 has $\bar{\rho}^2$ of 0.4038 and the coefficients are quite significant. Indeed, Model 2 seems to be one of the good models in terms of goodness-of-fit and parameter significance. We can conclude that the

logit model with only objective variables explain the mode choice behavior in Metro Manila better than that with perception and feeling variables, provided that pinpointing measurement of LOS variables was employed. It is dangerous to conclude, directly from this comparison, that the mode choice decisions of people in Metro Manila are not subjective and rational, because we could not find strong correlation between perception and measured LOS. However, this result shows that objective models can work well or better than subjective models to explain people's mode choice behavior.

Model 1 Vs. Model 3

Model 3 is Model 1 augmented with the variables of Model 2. It is observed that the Model 1's ρ^2 jumped up from 0.28 to 0.40, almost one and half times, when objective variables are introduced into the subjective model (Table 5-3). Comparing Model 3 with Model 1 and inspecting the parameter estimates, the perception and feeling variables greatly change their coefficients and t-statistics, suggesting big effects caused by the inclusion of objective variables.

Model 2 Vs. Model 3

Comparison of Model 2 with Model 3 confirms that the goodness-of-fit and the parameter estimates of objective variables are very stable regardless of the specifications of newly introduced subjective variables. These results imply that the respondents' subjective evaluation of modes do not significantly increase the goodness-of-fit of models and have little effects on model estimation.

6. CONCLUDING REMARKS

The common assumption that status consciousness influences mode-choice behavior in Metro Manila is being tested. It is likewise hypothesized that if this is true, then including subjective factors in the ordinary logit model will result in a better model in terms of explanatory power.

Along with HIS 1987, the Transport Mode Preference Survey was conducted. Cross-tabulation and correlation analysis show that status consciousness affects mode choice and can be substituted for ought-consciousness. However, perception variables have very low correlation coefficient with LOS and SE variables. This can be attributed to the possibility that the respondents could have accounted for a general situation and not the particular mode they took. This was anticipated and the questionnaire was made very carefully through preliminary surveys. However, it seems difficult to avoid this bias because the respondent might still have answered general perceptions toward all the modes, even if he or she had not actually taken them. Hence, his or her personal biases might have entered.

Logit model estimation results show that precisely pinpointed and measured LO_ variables are not as powerful as explanatory variables of mode choice behavior as objective variables. The goodness-of-fit of the model with only objective variables is much better than that with subjective variables only. Introducing objective variables into the models with only subjective variables increases model goodness-of-fit and changes the parameter estimates drastically. On the other hand, introducing subjective variables does not change model goodness-of-fit and the parameter estimates of objective variables largely. From these facts, we may conclude that attitudinal variables affect mode choice behavior, but slightly, and that these effects can be expressed through the use of SE variables.

As far as ordinary transportation planning is concerned, the ordinary logit planning seems to be appropriate. Inclusion of subjective variables is not necessary to get accurate and useful travel demand forecasting models. In this regard, we can say that people in the developing countries behave as rationally as people in the developed countries in transportation mode choice.

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