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INCOME EFFECT IN INTER-ISLAND PASSENGER MODE CHOICE FOR THE WESTERN VISAYAS REGION, PHILIPPINES

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ABSTRACT

This research aims to determine the presence of income effect in the inter-island passenger transport of Panay and Negros in the Western Visayas region of the Philippines. This effect is of great significance for developing countries where the transportation expenditure may comprise a substantial fraction of the household budget. In this research, logit choice models for each income class combination were specified. Results showed that income effect exists in the dataset since the marginal utilities of income among income classes differ significantly. This result is important in mode choice modeling for the inter-island passenger transport in the region. Accounting for income effect leads to unbiased model parameter estimates. The models also indicate that mode choice is affected by total cost and ration of access time to total travel time.

Keywords: *income effect, inter-island transport, mode choice*

1. INTRODUCTION

Inter-island transportation system plays an important role in the successful flow of goods, services and people. The Western Visayas region is located at the central part of the Philippine archipelago. It consists of three main land masses with six provinces namely, Aklan, Antique, Capiz, and Iloilo in the island of Panay, Guimaras in Guimaras island, and Negros Occidental in the island of Negros, as shown in Figure 1. The distance between the islands of Panay and Negros is 39.32 km. Most of the trip between the two islands are generated by people either going home or having the vacations. Also, the frequency of travel may be classified as infrequent as majority of the commuters between Iloilo and Bacolod make semi-annual or annual trips.

This region has a significant contribution to the gross domestic product (GDP) and along with its increasing growth rates in the past years; it may significantly help in strengthening the nation's economy. Due to its geographic orientation, an efficient inter-island transport system is necessary to foster economic growth since accessibility is a determining factor. Because of this condition, there is a need to conduct a study that will address the commuter's behavior on mode choice. Analysis is achieved through the use of discrete choice modeling where the socio-

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demographic characteristics of the commuters and the modal attributes are analyzed and related to the individual choices made by the commuters. In this way, the demand for the various transport alternatives may be estimated and the effects of certain policies assessed. The Western Visayas region is composed of several islands where the flow of goods, services, and people often require inter-island transport. This may pose hindrances to the development of the region, specifically Iloilo City in the island of Panay and Bacolod City in Negros which are the main urban centers of the region. An affordable, accessible, and reliable inter-island transport system is necessary in order to foster economic growth in the region (Fillone et al., 2011). Therefore, there is a need to determine whether such an enormous undertaking is feasible. The first step would be to understand how the commuters in the are a choose the modes for travel. The factors that influence these choices need to be addressed.

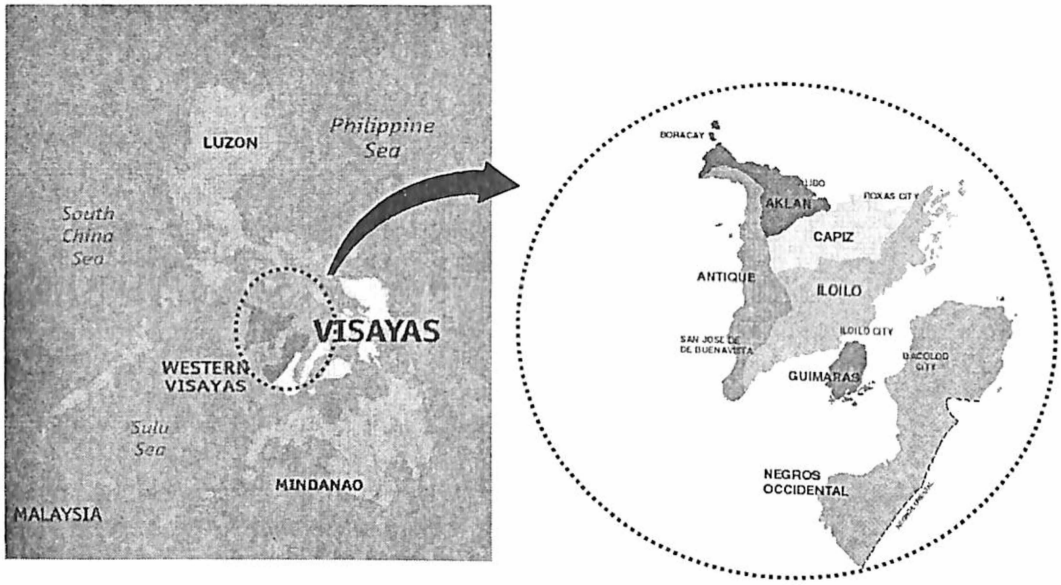

Figure 1. Map of Western Visayas (Region VI)

This research intends to determine whether income effect exists in the inter-island passenger transport between Panay and Negros. Essentially, this study will verify whether the income of respondents affects mode choice based on basic theories of microeconomics. To facilitate the investigation, several binary logit choice models were developed for each income class in the dataset.

This paper is organized as follows. First a review of literature is presented to describe the previous studies on income effect. Next, the theory and methodology is discussed which includes the concepts and the study area. After this, results are presented. Finally, some conclusions are drawn from the model estimates.

2. LITERATURE REVIEW

Income effect is often ignored or assumed to be negligible in modeling commuter choice (Jara-Diaz and Videla, 1989). Previous arguments state that transportation expenditures comprise just a small fraction of the total budget of the commuters (Cherchi and Polak, n.d.). However, this may not be true for developing countries where the aggressive transport pricing policies considered worldwide contribute to this. Income, even if included in the specification is often thought of as a proxy variable for taste (Jara-Diaz and Videla, 1989) and (Viton, 1985), though the two are not the same (Jara-Diaz, 1991). Jara-Diaz (1991) has shown that ignoring income effect or inappropriately accounting for it is incorrect.

Determining the effect of income in mode choice is a dilemma for planners since its most appropriate specification in the model have not yet been established (Jara-Diaz and Videla, 1989); (Cherchi and Polak, n,d,). Some planners simply insert the income attribute in the model account for its effect in commuter choice. However, this may be inappropriate as income is being treated like any other socio-economic variable in the model as if the transportation costs do not affect the wealth or budget of a commuter (Cherchi and Polak, n.d.) There are other methods of including income in the model like the common way of dividing the cost by the individual income, linear in cost or a logarithm transformation, logarithm of income minus cost, the Translog and the Leontief model (Cherchi and Polak, n.d.). However, this study focuses on the methodology proposed by Jara-Diaz and Videla (1989) where the dataset is segmented into different income classes (Jara-Diaz and Videla, 1989). This way, the computation of the different marginal utilities of income among the different income classes is facilitated. It has been shown that the marginal utility of income should decrease with income. In their research, the methodology was applied to work trips at the business district in Santiago, Chile where only land transportation modes were in the choice set. In contrast, the same methodology will be applied to the Western Visayas Region which is an average region in a developing country.

When income effect is not considered in the models, then it will result to biased parameter estimates (Jara-Diaz and Videla, 1989). Incorrect measurement of the utilities would result if a certain policy will alter the cost of transportation.

3. METHODOLOGY

3.1. Analytical

Utilities can be divided into two parts, the systematic component and the disturbance or random component. The systematic component of utilities for the different alternatives is just an ordinal measurement. In specifying the systematic component the linear combination of the estimated parameters and the attributes of the alternatives are taken. The error terms are assumed to be independent and identically Gumbel distributed in a binary logit model where the choice probability may be specified as

$$P_n(i) = \frac{e^{\mu V_{in}}}{e^{\mu V_{in}} + e^{\mu V_{jn}}} \quad (1)$$

Using this modeling tool, the determination of the existence of income effect is facilitated. The methodology presented is based solely on the concepts and theories presented in Jara-Diaz and Videla (1989). The following procedure summarizes the test as developed by Jara-Diaz and Vedela (1989).

1. Check whether the coefficient of the square-of-the-cost term is positive and significant.
2. If yes, then, divide the dataset according to modeler-specified income strata.
3. Add a square-of-the-cost term, c^2, to each of the different linear specification of the models for each income class. This specification is also a function of cost and other modal attributes. This is done since only a higher-order Taylor series expansion of the linear model reveals the effect on income in mode choice.
4. Test the significance of the added term, c^2, by using the values from the variance-covariance matrices of the coefficients.

Furthermore, there are three additional properties that need to be satisfied by the models developed.

1. The cost coefficient is negative and its absolute value should decrease with the income
2. The square-of-the-cost coefficient is positive and should decrease with income
3. Lambda should also decrease with income;

$$\lambda_i = -\alpha_c - \alpha_{c^2} c_i \tag{2}$$

where the α's are the coefficients of the cost and square-of-the-cost terms and λ is the marginal utility of income.

3.2. Data Collection

For this research, questionnaire surveys were administered from February to May 2013 at the two main port terminals of Iloilo province located in Iloilo City and in the municipality of Dumangas, as shown in Figure 2, since the target respondents are actual users. Most, if not all, of the trips from Panay going to Negros pass through these ports. A total of 1171 samples were gathered, in which the respondents were travelling from the island of Panay to Negros. Information such as the respondent's socio-economic characteristics, detailed travel costs and travel time for each trip segment, and other details were collected for this study.

There are various ways by which one may travel around the Western Visayas region, specifically, between the islands of Panay and Negros as shown in Figure 2. Roll-on/Roll-off (RORO) services and fastcraft ferry operations provide direct link between these islands. RORO services between Iloilo and Bacolod (Route A) are available every 2 to 3 hours, night and day. The port is located in Dumangas, the northern part of Iloilo. There are also fastcraft ferry operations (Route B) between Iloilo City and Bacolod City which are operated by three shipping companies. These three companies combined are responsible for providing 20 trips per day per direction from 6:00AM until 6:30PM. Another alternative in going from Iloilo to Bacolod is to pass through the island of Guimaras where pump boats generally leave the wharf every 15 minutes. There are two ways to traverse the island of Guimaras from Iloilo. One way is to go via the Buenavista route (Route C) and the other one is through Jordan (Route D) but both of

these routes converge in San Lorenzo where 2 daily pump boat trips take the commuters from San Lorenzo, Guimaras to Pulupandan in Negros Occidental. However, only routes A and B are included in this current study due to the small number of sampled commuters using the routes passing through Guimaras.

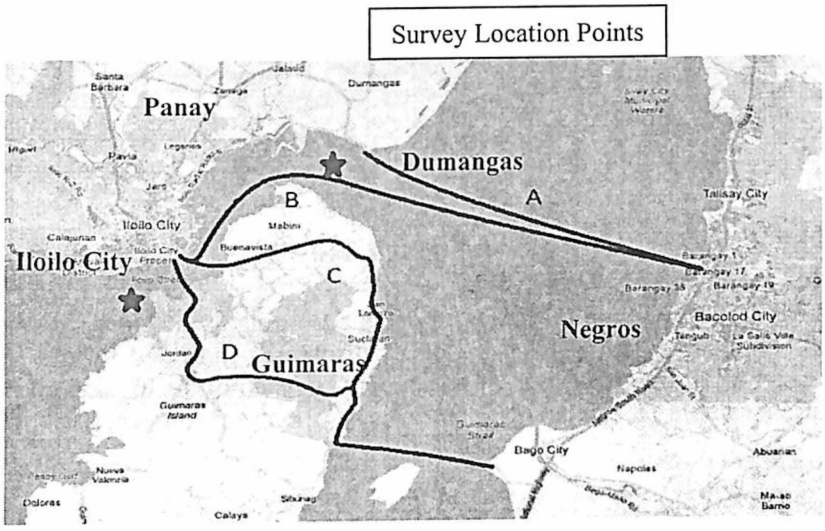

Figure 2. Major Iloilo - Negros Occidental travel routes
Source: (Google Maps, [2013])

The RORO and fastcraft service characteristics used to travel from Iloilo to Bacolod are shown in Table 1. On the average, the fastcraft ferry in Iloilo City serves more passengers on a daily basis due to the larger passenger capacity and slightly more frequent trips than the RORO. The fastcraft ferry is also faster as compared to the RORO. However, the fare for the fastcraft ferry is almost four times more expensive than that of the RORO which docks in Dumangas. The RORO port is approximately 28 kilometers north of Iloilo City or one hour land travel from the city proper on the average.

Table 1. Iloilo - Negros Occidental inter-island main travel options.

Transport Mode	Average Number of Passengers per trip	Average Number of Trips per day	Average Travel Time by sea [*Hour*]	Travel Fare [*PHP/pax*]
RORO (Roll-on Roll-off) [Route A]	95	19	2.15	80
Fastcract Ferry [Route B]	195	23	2	335

The presence of income effect in mode choice should be checked as it is often ignored in modelling. This may be necessary since the total transportation expenditure for a month may be a significant portion of the total income or household budget for that particular month especially in the case of the Western Visayas region in the Philippines. Table 2 shows the number of families in the region according to their respective income classes as indicated by

the National Statistics Office (NSO). It can be seen that majority of the families have relatively small monthly budgets.

Table 2. Number of families by income class in the Western Visayas region

Source: (NSO, 2013)

Income Class – Monthly (in PHP)	Number of families (2009 NSO)	Number of respondents (Sample)
Under 3300	75,000	119
3301 – 5000	166,000	185
5001 – 8300	412,000	234
8301 – 20830	584,000	346
20831 and over	215,000	287

Note: USD1 = PHP40.69

4. RESULTS

Table 2 shows the distribution of the respondents according to different income classes in the sample which is comparable to the distribution of income as indicated by the NSO. Figure 3 shows a clearer picture of the proportion of respondents in each of the income classes in the NSO data and the current sample. It can be seen that the proportions are comparable.

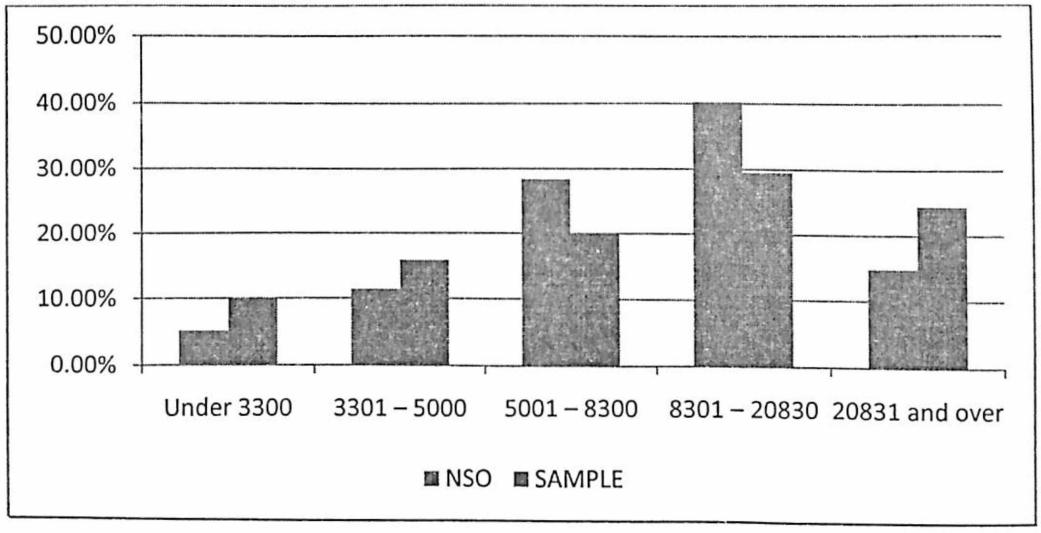

Figure 3. Income distribution comparison of NSO data and sample

The dataset compiled for this study is composed of an almost equal number of male and female respondents. Approximately 36% of the respondents chose the RORO while the remaining 64% chose fastcraft ferries to travel from Iloilo to Bacolod City. The average age of the commuters is roughly 33 years old. The number of single and married respondents is almost the same. The mean personal income is approximately 16,000 Philippine pesos (PHP) per month (≈PHP40.69 = USD1.00, Feb. 2013). Aside from these, it is interesting to note that most of the trips between Iloilo and Negros Occidental are either for leisure or vacation trips or going home, as shown in Figure 4.

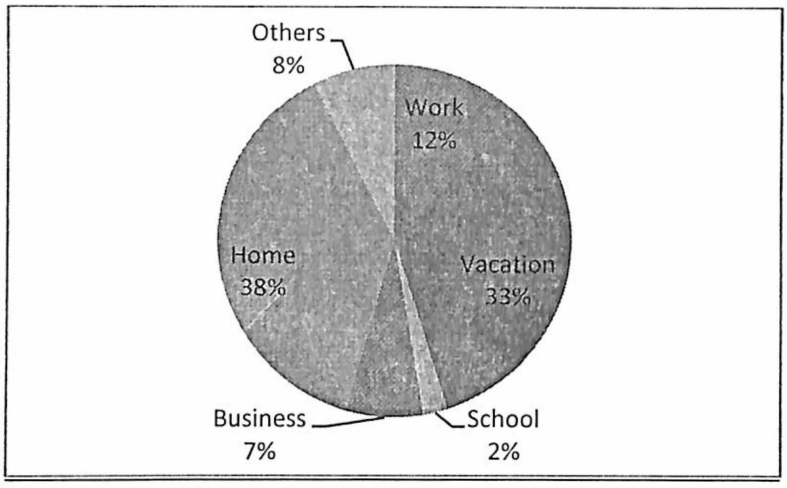

Figure 4. Classification of respondents according to trip purpose

Using the whole sample, a binary logit model is formulated. Table 3shows that TOTCOST2, square of total cost attribute, is positive and significant. This suggests that the whole sample should be divided into different income classes to check for differences in the marginal utilities of income among the income groups. Looking into the overall model, second column of Table 3, the fastcraft ferry is more desirable than the RORO service because of the negative coefficient of the constant term for RORO. Also, work trips are more likely to use the fastcraft ferry due to the positive value of its coefficient. The total cost and time parameters have negative values which mean disutility for users, which are expected. The time attribute in this model is defined to be the ratio of the access time to the total travel time for the respondent. Out of all the specifications for the concept of travel time, this proved to be the most significant definition. If an analyst would wish to check the effect of altering the travel time, the respondents are more sensitive to the access time as a fraction of the total travel time since the in-vehicle time is constant for the two available alternatives.

Using the income-segregated dataset, different binary logit choice models for the different possible income class combinations were developed before arriving at the groupings used for this study. For the income strata used in this paper, the author combined the first two classes and the last two classes into single income classes, reducing the number of NSO-specified income classes to three, as seen in Table 3. A square-of-the-cost term is added to the utility function to verify the existence of income effect. Table 3 also shows the alternative specific constant for RORO (α_{RORO});trip purpose–work ($\alpha_{purwork\ FASTCRAFT}$); the TIME parameter, which is defined as the ratio of access time to total travel time; and the coefficients total cost (TOTCOST) and the total cost-squared (TOTCOST2) variables for the three final income classes identified for this study. The constant term for RORO and the trip purpose - work are significant, at a 95% level of confidence, in the whole dataset except for $\alpha_{purwork}$ in income group(1) and (2), see Table 3. The TIME parameter has the correct sign and is also significant across the different income classes. It can also be observed that the coefficients of the costs are all significant, negative, and the absolute values decrease with income. As for the square - of - the-cost term, the coefficients are all significant, except for the PHP8,301-and-above income group, positive and the coefficients decrease with income as well. These conditions satisfy the first three properties for the determination of income effect mentioned

earlier. It should also be noted that the models presented in Table 3 are all significant, as indicated by the *p*-value.

Table 3. Estimated Coefficients for TOTCOST and TOTCOST2 *(t-statistic in parentheses)*

Variable	ALL	0 - 5000	5001 - 8300	> 8300
		Income group (1)	Income group (2)	Income group (3)
α_{RORO}	-1.1607246	-1.4196857	-1.3785008	-1.0047637
	(0.0000000)	*(0.0004000)*	*(0.0049000)*	*(0.0001000)*
$\alpha_{purwork\ FASTCRAFT}$ (1 = to work; 0 if not)	0.8630155	1.4534331	0.9726541	0.7166778
	(0.0023000)	*(0.1023000)*	*(0.1201000)*	*(0.0388000)*
TOTCOST	-0.0091477	-0.0158377	-0.0154861	-0.0050873
	(0.0000000)	*(0.0001000)*	*(0.0003000)*	*(0.0184000)*
TOTCOST2	0.0000076	0.0000141	0.0000137	0.0000041
	(0.0000000)	*(0.0019000)*	*(0.0015000)*	*(0.0313000)*
TIME	-0.1000600	-0.1121264	-0.0862232	-0.1024211
TIME origin-/TIME total	*(0.0000000)*	*(0.0000000)*	*(0.0000000)*	*(0.0000000)*
Log likelihood	-98.5010000	-120.2285000	-109.7383000	-260.2156000
Chi-squared	527.9789600	162.7811200	99.3558200	273.8474700
p-value	*(0.00000)*	*(0.00000)*	*(0.00000)*	*(0.00000)*
Sample size	1,171	304	234	633

From the results in Table 3, the marginal utility of income may be computed. Table 4 shows the marginal utility of income for each income class including the corresponding *t*-values. It can be seen that the λ's are all significant, having large *t*-statistic values.

Table 4. Marginal utility of income at different income levels

Income Group	$\lambda(c_i)$	$\lambda(\bar{c})$ (*t*-statistic)
0-5000 **(1)**	0.01583771-0.0000141374ci	0.011133863 *(5.36)*
5,001-8,300 **(2)**	0.0154861-0.0000137247ci	0.011012424 *(5.63)*
8,301 and above **(3)**	0.00508726-0.00000413596ci	0.003713792 *(5.95)*

A test for the difference between the marginal utilities for each income group is finally performed according to the procedure outlined by Jara-Diaz and Videla (1989). Table 5 shows the comparison of the λ's in the different income groups. The test indicates that the null hypothesis stating λ_1 and λ_2 are equal and may not be rejected at the 95% level of confidence, as indicated by the small *t*-statistic. However, both λ_1 and λ_2 are statistically different from λ_3. This indicates that income class 1 and income class 2 cannot be distinguished from each other but both are significantly different from income class 3. Conversely, the added satisfaction or utility an additional income brings for income classes 1 and 2 can not be differentiated. Moreover, the added utility for income classes 1 and 2 are statistically distinct from income class 3. This result may be used when altering the cost of transportation alternatives in order to achieve the desired outcome.

Table 5. Test on the difference of marginal utility of income between income groups.

Income groups considered	$\lambda_i(\bar{c}) - \lambda_j(\bar{c})$	(*t*-statistic)
(1) (2)	0.000121439	*0.042561*
(1) (3)	0.007420071	*3.419718*
(2) (3)	0.007298632	*3.556456*

Since it has been established that income classes (1) and (2) are indistinguishable from each other while being statistically different from income class (3), it can be said that the marginal utility of income differs significantly above and below the PHP8,300 level of income per month. In this regard, (1) and (2) were again combined to a single class and was differentiated against the last income class. Results from this new comparison corroborated the previous results shown in Table 5.

5. CONCLUSION

Income is often neglected I mode choice models. If included, it serves as a proxy variable for other attributes. This is often incorrect as the model specification may be microeconomically inconsistent and the welfare analysis will also be incorrect (Jara-Diaz and Videla, 1990). This study determined the presence of income effect in the inter-island passenger transport in the region. The methodology for determining the income effect in mode choice developed by Jara-Diaz and Videla (1989) was applied to the dataset collected for the inter-island passenger transport between Iloilo and Negros Occidental in Western Visayas region.

Since an affordable, accessible, and reliable inter-island transport system is demanded in order to foster economic growth in the region, there is a need to accurately characterize how commuters respond to variations in policies and certain conditions. The factors that influence these choices need to be addressed. This is done through discrete choice modeling where demand for the various transport alternatives may be estimated and the effects of certain policies evaluated. Realistic and accurate models lead to less wastage of resources. Transportation planning forecasts are essential as social gains are contrasted against the different associated costs and therefore be able to rightfully guide in policy recommendations (Grisolia and Ortuzar, 2010).

Results show that the inter-island passenger mode choice between Panay, Guimaras, and Negros is affected by total travel costs and the ratio of access time to total travel time. Moreover, income effect was determined to exist in the dataset. The additional square of the total cost term added to the utility equation proved to be significant and satisfied the additional conditions indicated by the technique. Therefore, income class segregation of the whole dataset, where the marginal utilities of income were significantly different, was accomplished. The methodology of Jara-Diaz and Videla(1989) was able to show that the marginal utilities of income were different in some of the income classes. Jara-Diaz and Videla (1989) stated that when the income variable is not correctly included in the specification, unclear interpretations of the utility function may arise. They added that properly accounting for income effect is not a matter of model fit or accuracy of the forecast but a matter of correct understanding and evaluation of utilities. Result from this analysis can be used by transport planners to devise more sound infrastructure provision and management strategies. Lastly, income segregation ensures that user benefits are not underestimated when willingness to pay measures of commuters are considered, provided that income affects mode choice.

6. RECOMMENDATIONS

Other advanced choice modelling tools should also be explored to overcome the limitations of simpler models such as the multinomial logit modeling technique used in this study. Fellow researchers are also encouraged to grow interest in inter-island transport and other rural areas to shed light on less focused subjects of research. Much of the efforts are concentrated in the urban

areas such that literature involving inter-island transport and rural areas in the Philippines are scarce. Other locations in the Philippines where inter-island travel is essential may also be investigated in order to compare the conditions among the different sites.

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