AN ANALYSIS OF TRAVEL-ACTIVITY PATTERNS IN METRO MANILA

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Abstract - This study investigates the hypothesis that the 21.9 million daily trips[2] in Metro Manila can be grouped into smaller number of representative travel-activity patterns which shall be called as **clusters**. The study revealed that it can be grouped into five (5) major clusters, namely; those dominated by *work trips, non-fixed trips, no trips, school trips* and *multiple trips.* Linear logit models were fitted on the five (5) clusters utilizing thirteen hypothesized determinants of travel-activity behavior and found that the most important are Household Income, Age, Employment, Length of Travel (LT) and Number of Mode Transfers (TRANSFER).

1.0   INTRODUCTION

1.1   Background

Transportation demand analysis is the process of relating the demand for transportation to the socioeconomic activities that generate it. The type, level, and location of human activities are related to the demand for movement of people and goods between the different points in space where these activities take place. The results of this analysis are relationships. often in the form of models, between measures of activity and measures of transport demand (Kanafani, 1983). Transportation demand analysis then is useful in addressing a variety of policy issues and in providing quantitative inputs in urban transportation planning.

Individual urban travel behavior is the output of the travel-decision making process. If we are to plan and design urban areas that enhance quality of life, it is essential that urban travel behavior be understandable and predictable. Travel behavior can be defined on the basis of knowing how people allocate time and sequence activities. Goodwin (1983) states that 'Activity Approaches' to travel analysis means the consideration of revealed travel patterns in the context of a structure of activities, of the individual or household, with a framework emphasizing the importance of time and space constraints (Kitamura, 1988). The activity choices are interdependent in that the decision to engage in a particular activity at one point in time and space will affect the likelihood of other activities being undertaken. In peasant societies, time and space budgets may not have more relevance

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2 This data includes walk trips which was taken from Metro Manila Urban Transportation Integration Study (MMUTIS) database. a study conducted in 1996 for the Department of Transportation and Communications and funded by the Japan International Cooperation Agency.

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than personal time indicators such as "*biological clocks*" of hunger and tiredness than the impersonal clock-time. In early peasant tradition "to hurry is to forfeit freedom", i.e., the peasant is "intent on passing the time rather than on budgeting it" (Anderson, 1971).

Based on past studies on accessibility show that existing measures do not adequately represent the spatial, temporal, and t ansportation factors which limit the accessibilities of individuals to transport facilities, and consequently undertake urban travel and activities. The significant characteristics of these factors are their constraining influence on travel-activity behavior. In turn their behavior is interrelated and inseparable and are constraints which are directly influenced by the built-in or physical environment (Villoria, 1989). Recognizing the effects of the built-in or physical environment on individual travel-activity behavior is to incorporate the spatial, temporal and transportation factors knowing that socioeconomic characteristics alone are poor predictor of travel-activity behavior. The spatial, temporal and transportation factors that affect individual accessibility are represented by two (2) mobility indices called Length of Travel (LT) and Number of Mode Transfers (TRANSFER) which will be empirically tested in this study.

1.2 Objectives of the Study

The study aims to identify a representative travel-activity pattern of the 21.9 million daily trips in Metro Manila and analyze the socioeconomic characteristics of these groups of individuals who undertake the same type of travel-activity behavior. What socioeconomic determinants influence this travel-activity behavior? Given two (2) mobility indices Length of Travel (LT) and Number of Mode Transfers (TRANSFER), would each of these clusters consider one, both or none at all the mobility indices before he or she undertakes a trip?

1.3 Significance of the Study

The study will give us an idea of how individual travelers allocate time and sequence activities and how the two (2) mobility indices influenced their travel-activity behavior, depending on their socioeconomic characteristics. It is also useful to policy makers with respect to Transportation Demand Management (TDM) measures and Land Use Planning.

1.4 Limitations of the Study

The study shall be limited to the study area of Metro Manila Urban Transportation Integration Study (MMUTIS) which includes the cities and municipalities of Metro Manila and the four (4) adjoining provinces of Bulacan, Cavite, Laguna and Rizal. The study area has a total of 315 zones, 264 zones for Metro Manila and 51 zones for the adjoining provinces.

2.0 REVIEW OF LITERATURE

2.1 Background of the Study

Understanding the basic nature of urban travel-activity behavior is a prerequisite to effective transportation planning and policy formulation. This study aims to determine a

representative travel-activity pattern of Metro Manila residents and its immediate environs which generates 21.9 million daily trips. The purpose here is to have a better understanding of the travel-activity behavior of the residents on a reduced scale, i.e., a few representative travel-activity patterns which will be known as **clusters**.

In this study, we shall identify those homogeneous clusters not only manifesting similar socioeconomic characteristics but also in their travel-activity behavior. These clusters will be analyzed based on their revealed travel-activity behavior of one day. The potential travel markets of these clusters will also be analyzed and determine what influenced this travel-activity behavior.

2.2   Activity-approach to Travel Demand Analysis

Travel making is considered a derived demand, i.e., individuals travel because there is a need for food, recreation, etc. The decision process to travel can be assumed to be the same for all travelers. Meaning that *if two travelers have the same personal characteristics and live in similar urban environments, they will have the same travel behavior* (Oppenheim, 1974). This is not however the case. Urban travelers with the same socioeconomic characteristics may manifest different travel-activity behavior. It is in this sense that activity-based approach to travel demand analysis plays an important role.

There are two (2) types of hypotheses which have been gathered in research as related to activity patterns. *First* are those which are logical and explicit expressions of a coherent and causal theory of why people behave as they do with respect to activities. *Second* are those hypotheses which emerge deductively from an assessment of the factors which could reasonably be expected to explain in whatever dependent variable has been chosen for empirical analysis (Damm, 1983). The first hypothesis assumes that in activity analysis, the activities that the individual undertakes are known only during the analysis. We followed the second hypothesis which identified *a priori* the activity set from which the individual may choose to undertake.

2.3   Variables Used in Cluster Analysis

In this study, the variables used for classifying individual travel-activity pattern were: (1) time started from home; (2) time ended at home; (3) number of fixed activities such as home, work, and school; (4) time spent at home; (5) time spent at work; (6) time spent at school; (7) time spent for private business; (8) time spent for employer's business; (9) time spent for medical & social activities; (10) time spent for eating and shopping; (11) time spent at church; (12) time spent for other activities; and (13) time spent traveling. The forgoing dimensions were selected in an attempt to capture a time-space representation of the total travel-activity pattern undertaken by an individual on a given day.

2.4   Mobility Indices as Determinants of Individual Travel-activity Behavior

The inclusion of mobility indices as determinants of travel-activity behavior is to account for the spatial, temporal and transportation factors affecting the different urban activities. Since we are using time of travel (time of travel *multiplied* by the average speed of the mode of transportation used *equals* length of travel), the linear response of distance is removed (Vickerman, 1974). The inclusion of TRANSFER is to compensate for the

information lost during mode transfers. The two (2) mobility indices Length of Travel (LT) and Number of Mode Transfers (TRANSFER) helps us in understanding individual accessibility.

3.0   DATA

3.1   Data Source and Extraction

The data for this particular study were taken from Metro Manila Urban Transportation Integration Study (MMUTIS). The data come in three (3) parts: FORM 1 contains the HOUSEHOLD INFORMATION; FORM 2 contains HOUSEHOLD MEMBER INFORMATION; and FORM 3 contains the INDIVIDUAL ONE-DAY TRAVEL DIARY. Two sets of programs in Pascal were prepared to extract the data from MMUTIS database. The first program extracts data from FORM 2 while the second program matches the individual sample with his or her household information (FORM 1) and one-day travel diary (FORM 3).

3.2   The Data

A total of 5,945 representative individual samples were extracted from the MMUTIS database. All individual samples belong to different households. This represents 9.81% of the total number of households of the MMUTIS data. See Table 1 below.

TABLE 1

COMPARING NUMBER OF HOUSEHOLDS OF NCSO, MMUTIS & This Study

LOCATION	NCSO (STUDY AREA)	MMUTIS	This Study	NCSO versus MMUTIS	NCSO versus This Study	MMUTIS versus This Study
Metro Manila	1,987,659	49,144	4,868	2.47%	0.24%	9.91%
Adjoining Provinces	1,001,883	11,474	1,077	1.15%	0.11%	9.39%
Total	2,989,542	60,618	5,945	2.03%	0.20%	9.81%

NCSO - National Census and Statistics Office
Note: Adjoining Provinces includes Rizal, Bulacan, Cavite and Laguna.

4.0   CLUSTER ANALYSES

4.1   Variables Used in Cluster Analysis

The demand for travel has long been recognized as a derived demand which is motivated by the need or desire for activity participation at spatially separated locations. These needs and desires are satisfied within the constraints which limit the travel opportunities of the individual or household. Some needs and desires for activity participation require satisfaction less frequently than each day. For example, in societies where home refrigeration is commonly available, grocery shopping is typically not undertaken each day. Other activities require even more frequent participation, e.g., time spent at home (Pas and Koppelman, 1987).

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TABLE 2

SUMMARY OF CLUSTERS MEMBERSHIP by AGE, EMPLOYMENT & OCCUPATION

CATEGORY	TOTAL	CLUSTER NUMBER				
		1	2	3	4	5
AVERAGE AGE (Years)	28.85	33.96	34.47	33.91	12.81	37.65
EMPLOYMENT						
1. Agriculture & Forestry	0.67%	1.10%	0.79%	0.94%	0.00%	0.00%
2. Fishing	0.32%	0.76%	0.24%	0.34%	0.00%	0.00%
3. Mining & Quarrying	0.13%	0.41%	0.00%	0.09%	0.00%	0.55%
4. Manufacturing	6.01%	19.18%	2.81%	1.88%	0.20%	3.87%
5. Electricity, Gas & Water	1.01%	2.68%	0.98%	0.09%	0.00%	2.21%
6. Construction	3.04%	9.35%	1.16%	1.97%	0.07%	1.10%
7. Wholesale & Retail Trade	11.66%	17.53%	16.69%	10.27%	0.07%	24.31%
8. Hotels & Restaurants	1.75%	4.67%	1.71%	0.60%	0.00%	0.55%
9. Transport Storage & Communications	4.66%	9.00%	2.38%	2.65%	0.00%	41.99%
10. Financial Intermediation	1.40%	4.67%	0.43%	0.26%	0.13%	1.66%
11. Real Estate & Renting Business	1.73%	3.44%	1.83%	1.20%	0.07%	4.42%
12. Public Administration & Defense	2.51%	7.49%	1.47%	0.77%	0.00%	3.87%
13. Education	1.11%	3.30%	0.61%	0.34%	0.20%	0.55%
14. Health & Social Work	1.09%	3.64%	0.61%	0.09%	0.00%	0.55%
15. Other Social Services	3.35%	6.60%	3.42%	3.08%	0.13%	4.97%
16. Private Household	1.75%	1.03%	3.06%	2.48%	0.00%	5.52%
17. Extra-territorial Organization	0.05%	0.14%	0.06%	0.00%	0.00%	0.00%
Employed Employment Category (2,511 Samples)	42.24%	94.98%	38.26%	27.03%	0.86%	96.13%
Unemployed Employment Category (3,434 Samples)	57.76%	5.02%	61.74%	72.97%	99.14%	3.87%
Total	100%	100%	100%	100%	100%	100%
OCCUPATION						
1. Officials of Government, Managers & Supervisors	10.68%	12.85%	16.87%	10.18%	0.27%	27.07%
2. Professionals	3.18%	9.97%	1.77%	0.94%	0.0 %	1.66%
3. Technicians & Associate Professionals	2.15%	6.25%	1.16%	0.77%	0.00%	4.97%
4. Clerical Workers	2.66%	9.48%	0.49%	0.68%	0.07%	1.66%
5. Service, Market & Shop Workers	6.19%	16.49%	4.71%	2.99%	0.07%	8.29%
6. Farmers, Forestry & Fishermen	0.67%	1.17%	0.61%	1.11%	0.00%	0.00%
7. Trades & Related Workers	3.78%	10.72%	2.32%	1.71%	0.07%	5.52%
8. Plant & Machine Operators & Assemblers	4.54%	10.45%	2.51%	1.54%	0.07%	32.04%
9. Laborers & Unskilled Workers	8.01%	17.53%	7.40%	6.33%	0.20%	12.71%
Employed Occupation Category (2,489 Samples)	41.87%	94.91%	37.84%	26.26%	0.80%	93.92%
10. Elementary Students	16.90%	0.55%	8.25%	6.50%	52.26%	0.00%
11. High School & University Students	13.93%	2.06%	3.00%	3.93%	46.61%	1.10%
12. Housewife	13.94%	0.62%	31.66%	25.66%	0.07%	0.55%
13. Jobless	9.71%	0.21%	15.28%	27.46%	0.00%	1.66%
14. Others	3.65%	1.65%	3.97%	10.18%	0.27%	2.76%
Unemployed Occupation Category (3,456 Samples)	58.13%	5.09%	62.16%	73.74%	99.20%	6.08%
Total	100%	100%	100%	100%	100%	100%
NUMBER OF SAMPLES	5,945	1,455	1,636	1,169	1,504	181

Notes: The difference in the computation of the total percentages can be attributed to rounding off. Another noticeable difference are the total percentages of Employed, Employment Category against the total percentages of Employed, Occupation Category, the latter being always lower. It can be concluded that the Unemployed, Occupation Category such as Elementary, High School and University Students, Housewife, Jobless and Others are performing part time employment to fill the gap.

There are thirteen (13) variables used in the cluster analyses. The two (2) variables Time Started at Home and Time Ended at Home is in recognition of the fact that majority of all trips are home-based[3]. The variable Number of Fixed Trips is to account for the fact that there are certain activities that requires more frequent participation[4]. Fixed trips or activities are Home, Work and School.

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3 Of the 4788 individual samples who made a trip, only 22 individual samples are not home-based.
4 It should be noted that the residents of the Study Area spent 73.96% of their time at Home, 9.44% at Work and 7.71% at School, or a total of 91.11% spent at these fixed activities.

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The next nine (9) variables are the trip purposes or the <u>activity set</u>. These trip purposes are Home, Work and School which are considered as fixed activities and Private Business, Employer's Business, Medical and Social, Eating and Shopping, Church and Others which are considered non-fixed activities. These trip purposes will give us an idea of how an individual allocates time in each of these activities. The last variable is the Time Spent Traveling which will account for the spatial separation of these different activit es. Note that all the units of the variables are in time except for the Number of Fixed Trips'.

4.2   The Procedure FASTCLUS of SAS/STAT

The Procedure FASTCLUS of SAS/STAT combines an effective method for finding initial clusters with a standard iterative algorithm for minimizing the sum of the squared distances from the cluster means. The result is an efficient procedure for disjoint clustering of large data sets. From Procedure FASTCLUS of SAS/STAT, we found <u>five (5) clusters</u>[6] for the 5,945 samples. <u>See Table 2 above</u>.

5.0   MOBILITY INDICES

5.1   Introduction

The mobility indices in this study are LT and TRANSFER which are really nothing but the spatial, temporal and transportation factors that affects individual accessibility. The LT is the total length of travel of all modes of transportation, including walk, while TRANSFER is the total number of mode transfers, including walk, of an individual sample during the survey day.

5.2   Average Speeds of Modes of Travel

The average speeds were based on the data from the study for the Department of Public Works and Highways entitled Metro Manila Urban Expressways System Study (MMUESS) completed in 1993 and funded by the Japan International Cooperation Agency.

5.3   Summary

Based on the results, we can conclude that the cluster where the majority belongs to <u>transport storage and communications</u>[7] has generally high LT. In general, those

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5 Since this variable is not in units of time, it has to be standardized to mean zero and variance one by invoking Procedure STANDARD of SAS/STAT software

6 The five (5) clusters were further sub-clustered and found that Cluster 1 has four (4) sub-clusters. Cluster 2 has five (5) sub-clusters. Cluster 3 has two (2) sub-clusters. Cluster 4 has two (2) sub-clusters and Cluster 5 has two (2) sub-clusters. The *Thesis* provides complete details regarding socioeconomic characteristics, mobility indices and travel-activity patterns of the five (5) clusters and its corresponding sub-clusters.

7 Though the study revealed that <u>mining and quarrying</u> had the highest LT at 55.29 kilometers, the sample is not representative with only eight (8) comprising 0.32%. The only female of the eight samples made a 104.02 kilometers LT pulling up its average higher than the <u>transport storage and communications</u> which is 53.99 kilometers. The average number of trips for the <u>transport storage and communications</u> is 3.12, the highest among the seventeen (17) employment categories with Cluster 5 having the highest among the five (5) clusters at 3.71 trips while the average for the 4,788 tripmakers is only 2.32 trips. This explains the

unemployed have lower LT than those employed by a ratio of more than one is to two. Among the unemployed occupation categories, the high school and university students have the highest LT while the elementary students have the lowest[8] . See Table 3 below of the summary of the clusters' LT.

TABLE 3

CLUSTERS MOBILITY INDEX IN TERMS OF LENGTH OF TRAVEL (LT)

CLUSTER NUMBER	LT (KM.)	CLUSTER COMPOSITION	DESCRIPTION OF CLUSTERS
1	35.49	*EMPLOYMENT* MANUFACTURING = 19.18% WSALE & RETAIL TRADE = 17.53% CONSTRUCTION = 9.35% TRANS. STORAGE & COMM. = 9.00% PUB. ADM. & DEFENSE = 7.49% Employed = 94.98%	**MOSTLY WORK TRIPS** LONG LT & VERY HIGH EMPLOYMENT RATE
2	27.25	*EMPLOYMENT* WSALE & RETAIL TRADE = 16.69% Employed = 38.26% *OCCUPATION* HOUSEWIFE = 31.66% OFF. OF GOVT., MNGRS. & SUPVSRS. = 16.87% JOBLESS = 15.28% ELEMENTARY STUDENTS = 8.25% LABRS. & UNSKILLED WKRS. = 7.40%	**MOSTLY NON-FIXED TRIPS** MEDIUM LT & LOW EMPLOYMENT RATE
3	0.18	*EMPLOYMENT* Employed = 27.03% *OCCUPATION* JOBLESS = 27.46% HOUSEWIFE = 25.66% OFF. OF GOVT., MNGRS. & SUPVSRS. = 10.18% OTHERS = 10.18% ELEMENTARY STUDENTS = 6.50% LABRS. & UNSKILLED WKRS. = 6.33%	**MOSTLY NO TRIPS** VERY LOW LT & LOW EMPLOYMENT RATE
4	11.86	*EMPLOYMENT* Employed = 0.86% *OCCUPATION* ELEMENTARY STUDENTS = 52.26% HIGH SCHOOL STUDENTS & UNIVERSITY STUDENTS = 46.61%	**MOSTLY SCHOOL TRIPS** LOW LT & VERY LOW EMPLOYMENT
5	57.42	*EMPLOYMENT* TRANS. STORAGE & COMM. = 41.99% WSALE & RETAIL TRADE = 24.31% Employed = 96.13%	**MOSTLY MULTIPLE TRIPS & TRIP TYPE IS EMPLOYER'S BUSINESS** VERY LONG LT & VERY HIGH EMPLOYMENT RATE

Note: The other employment and occupation categories were not included because its contribution to the cluster composition is negligible. For example, in Cluster 5, Transport Storage & Communications (41.99%) and Wholesale and Retail Trade (24.31%) have a total of 66.30%, meaning that 33.70% belongs to the other 15 employment categories, or roughly just over two (2) percent each.

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reason why Cluster 5 were 41.99% belongs to transport storage and communications had the highest LT and can be aptly described as those dominated by multiple trips. Furthermore, Cluster 5 had the highest possession of driver's license at 53.04% against the average of only 11.49%. On the contrary, Cluster 5 had the lowest TRANSFER at 1.37 with Cluster 1 having the highest at 2.41 while the average for the 4,788 tripmakers is 1.86, implying that Cluster 5 is dependent on the private mode of transport or the driver of a public utility vehicle.

8 In general, the average LT is 20.97 kilometers, 13.59 kilometers for the unemployed while 31.06 kilometers for the employed. Under the unemployed occupation category, Elementary Students have the lowest Length of Travel at 5.60 kilometers, Housewife at 15.48 kilometers, Jobless at 15.48 kilometers, Others at 13.71 kilometers while the High School and University Students have the highest at 20.28 kilometers.

6.0 TRAVEL-ACTIVITY ANALYSIS
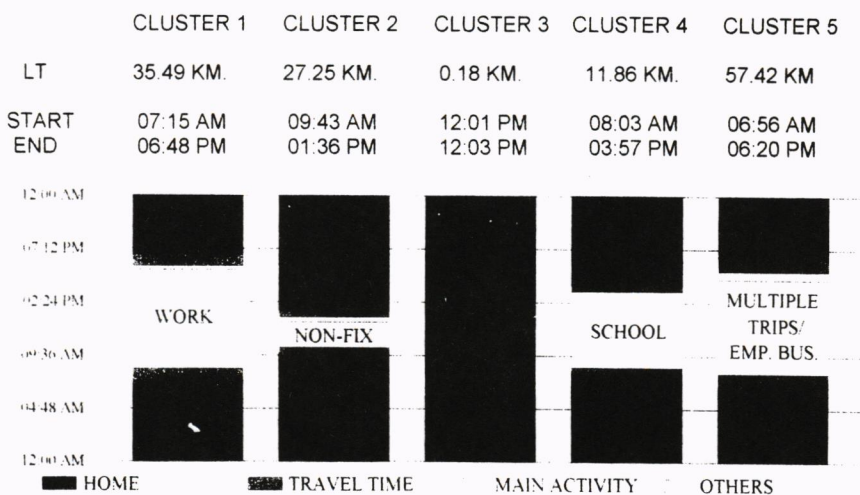
6.1 Introduction

In this chapter, a better understanding of how individuals belonging to different clusters allocate their time on different activities. Since activity-based approach to travel demands analysis should be analyzed as a link-sequence of activities, it is only proper to view individual travel as a continuous process. As much as possible, those individuals with the same socioeconomic characteristics and manifesting the same travel-activity pattern should be treated as one cluster.

6.2 Time Allocation at Different Activities

Generally, individuals spend 73.96% (1,065 minutes) of their time at home, 9.44% (136 minutes) at work, 7.71% (111 minutes) at school, 4.79% (69 minutes) travel time, and 4.10% (59 minutes) for private business, employer's business, medical and social, eating and shopping, church, and others. The five (5) clusters' travel-activity participation is presented in Figure 1 below.

FIGURE 1

TRAVEL-ACTIVITY PARTICIPATION BY CLUSTER

	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4	CLUSTER 5
LT	35.49 KM.	27.25 KM.	0.18 KM.	11.86 KM.	57.42 KM
START	07:15 AM	09:43 AM	12:01 PM	08:03 AM	06:56 AM
END	06:48 PM	01:36 PM	12:03 PM	03:57 PM	06:20 PM

HOME   TRAVEL TIME   MAIN ACTIVITY   OTHERS

NOTE: OTHERS means all other activities that were lumped because the time spent for these activities were too short.

Cluster 1 - This cluster is dominated by work trips. On the average, the cluster members leave home at 7:15 a.m. and arrive home at 6:48 p.m. This cluster has a high employment rate at 94.98%.

Cluster 2 - This cluster is dominated by non-fixed trips. On the average, the cluster members leave home at 9:43 a.m. and arrive home at 1:36 p.m. Only 38.26% of the cluster membership are employed.

Cluster 3 - This cluster is dominated by no trips. Most of the activities of this cluster were spent at home. Only 27.03% of the cluster membership are employed.

Cluster 4 - This cluster is dominated by school trips. On the average, the cluster members leave home at 8:03 a.m. and arrive home at 3:57 p.m. Most of the cluster members are students at 98.87%.

Cluster 5 - This cluster is dominated by r·ltiple trips with employer's business as the dominant activity type characterized by very long LT. On the average, the cluster members leave home at 6:56 a.m. and arrive home at 6:20 p.m. Most of the cluster members are employed at 96.13%, the highest employment rate among the five (5) clusters.

7.0. DETERMINANTS OF TRAVEL-ACTIVITY BEHAVIOR

7.1 Variables for Calibration

The type of variables that we are dealing with in this study are mostly categorical, e.g., sex, employment, occupation, etc. A categorical data is defined as one that can assume only a limited number of discrete values, e.g., male or female. A categorical variable can be nominal, which means that the observed levels are not ordered. We have a total of thirteen (13) variables hypothesized as determinants of travel-activity behavior nine (9) of which are categorical and four (4) to be treated as continuous variables, i.e., HH_INC, PER_INC, TRANSFER and LT. A software that can easily handle this type of analysis is Procedure CATMOD or Categorical Model of SAS/STAT. Procedure CATMOD fits linear models to functions of categorical data, facilitating such analyses as regression, analysis of variance, linear modeling, log-linear modeling, logistic regression, and repeated measures analysis. See Table 4 below for the variables used as determinants of individual travel-activity behavior.

TABLE 4

HYPOTHESIZED DETERMINANTS OF TRAVEL-ACTIVITY BEHAVIOR

SOCIOECONOMIC CHARACTERISTICS		MOBILITY
HOUSEHOLD	PERSONAL	INDICES
HH Income (HH_INC)	Age (AGE)	No. of Mode Transfers (TRANSFER)
HH Car Ownership (CAR_OWN)	Sex (SEX)	Length of Travel (LT)
HH Life_Cycle (LIFE_CYC)	Disability (DISAB)	
	License (LICENSE)	
	Occupation (OCCU)	
	Employment (EMP)	
	Personal Income (PER_INC)	
	Type of Office (OFFICE)	

HH - Household
HH_CYC 1 - for HH w/o helper and w/ disabled HH member   OFFICE: 1 - No Office
        2 - for HH w/ helper and w/ disabled HH member   2 - Fixed Time
            for HH w/o helper and w/o disabled HH member   3 - Flexible Time
        3 - for HH w/ helper and w/o disabled HH member

7.2. Modeling Approach

STEP ONE - Linear model method of Procedure CATMOD (Categorical Model) was used in this step. The emphasis of this method is estimation and hypothesis testing of the

model parameters. This method is however not suitable for model building.

STEP TWO - The first step had already identified those variables that have the strongest explanatory power to the model. From the first step, we are hinted on what variables to test first. Still invoking Procedure CATMOD, we will fit a model using log-linear model methods. The emphasis of this method is on model building, goodness-of-fit tests, and estimation of cell frequencies and probabilities for the underlying contingency table.

7.3   Determinants of Travel-activity Behavior of Clusters

A fully saturated model with two-variable interaction effects will be calibrated in this step with a reduced number of variables. In selecting a good fitting model, the first consideration is whether the variables tested in the model is significant or not without first considering the variable interaction effects. If the variable is not significant, is it significant with two-variable interaction? If the variable alone is significant or significant with two-variable interaction, then that variable may be considered in the final model. The models that we have calibrated were clustered prior to calibration. The clustering procedure pooled into groups those individuals showing the same travel-activity pattern. The clustering procedure gave us five clusters: (1) those dominated by work trips with 1,455 samples; (2) those dominated by non-fixed trips, e.g., shopping and eating, with 1,636 samples; (3) those dominated by no trips with 1,169 samples; (4) those dominated by school trips with 1,504 samples; and (5) those dominated by multiple trips with 181 samples. The clustering procedure practically pre-fitted the models thereby giving us very robust models as shown in Table 5. We shall explain all the models of the five clusters.

CLUSTER 1 - A total of twenty-four (24) models were calibrated in this cluster. The variables in the final model are HH_INC*AGE*EMP*TRANSFER with a ρ-value of 0.9997 way beyond the minimum of 0.10 and 0.35.

HH_INC and AGE variables, as found in many previous travel demand analyses are the most important determinants of travel-activity behavior, and this study is no exception. The presence of variable EMP is expected since the dominant trip type of this cluster is work. The presence of TRANSFER variable however needs a little scrutiny. Metro Manila residents, if given the option, will choose to live near the place of their work for the sake of convenience such as reduction of LT and TRANSFER, as mostly are non-car owning households at 88.38%. Having both options, reduction of LT and TRANSFER entails a lot of trade-offs. This could only mean living in congested residential areas in Metro Manila such as the Sampaloc district or if finances warrants, in condominiums in Pasig or Makati. Affordability of these condominiums is however beyond the reach of an ordinary employee, leaving ordinary employees the option of having to live in areas far from their work places such as the socialized housing projects of the government found mostly in the periphery areas of Metro Manila which are environmentally pleasant, safe and affordable. The consideration then left to the ordinary employee is TRANSFER. LT considered as being taken. Having a lot of mode transfers results in a lot of inconveniences such as additional waiting time. Consider an employee looking for an apartment or boarding house, as these are the only housing affordable in Metro Manila for an ordinary employee, the first question that he or she asked is, *how many rides to work?*, a manifestation of Metro Manila working residents preference for *'isang sakay lang'* or one ride. A very good example are the DPWH personnel who lives as far as Malolos, Bulacan. Most of

these personnel can avail but not all, the transportation services provided by the office. Note that the only consideration left to them is how to reach their destinations in just one ride, LT being given. As a matter of fact, sort of justifying the situation, longer travel means rest, i.e., they can sleep while in transit. Length of Travel (LT) did not came out as important determinant of travel-activity behavior in this cluster, firstly, because LT and HH_INC are directly related to each other, and secondly, this clu: ter's trip type is a fixed type, meaning that both options, shorter LT and lesser TRANSFER, has a high price to pay for if available, cost and living environment. Therefore, this cluster cannot be choosy in availing both conveniences of travel, i.e., shorter LT and lesser TRANSFER.

CLUSTER 2 - A total of twenty-nine (29) models were calibrated in this cluster. The variables in the final model are HH_INC*EMP*TRANSFER*LT with a ρ-value of 0.9760 way beyond the minimum of 0.10 and 0.35.

As with Cluster 1, HH_INC variable is an important determinant of travel-activity behavior. The presence of EMP variable needs further investigation. The composition of the cluster as to OCCUPATION category are as follows: ELEMENTARY STUDENT, 135 (8.25%); HIGH SCHOOL & UNIVERSITY STUDENTS, 49 (3.00%); HOUSEWIFE, 518 (31.66%); JOBLESS, 250 (15.28%); and OTHERS, 65 (3.97%). The total of these five (5) unemployed occupation categories is 62.16%. Should not OCCUPATION be one of the explanatory variable in this cluster? That question above could be easily answered if we know the trip type this cluster is dominated. Majority of the cluster members made non-fixed trips such as Private Business, Employer's Business, Medical & Social, Eating & Shopping, Church, and Others as opposed to fixed trips such as Home, Work, and School. Note that for these trips to be undertaken one need not be unemployed, except for Employer's Business. We cannot also rule out the possibility that housewives, jobless and others are performing part time employment or a day-off for those employed, precisely the presence of EMP variable (See Footnote in Table 2). Obviously, we can make a comparison of this cluster and the previous one. The previous cluster was dominated by fixed trips such as work trips while this cluster is dominated by non-fixed trips. Non-fixed trips by its very nature need not be performed at specific time and place, i.e., time and place constraints is not a consideration. Therefore, travelers of this type of trip can have the luxury of availing both conveniences of travel, shorter LT and lesser TRANSFER. For example, as to time constraints, shopping can be done on a Saturday or maybe after office hours. As to place constraints and using the same example, shopping can be done at the nearest supermarket or farther away but offers a competitive price than the nearest one. This cluster can be choosy as to conveniences of travel. While fixed trips have to be performed at specific time and place curtailing conveniences to travel, non-fixed trips is just the opposite. This is the reason why both mobility indices, LT and TRANSFER came out as important determinants of travel-activity behavior in this cluster.

CLUSTER 3 - A total of twenty-one (21) models were calibrated in this cluster. The variables in the final model are HH_INC*AGE*SEX*EMP with a ρ-value of 0.9590 way beyond the minimum of 0.10 and 0.35.

The presence of HH_INC in the final model only reinforces the results of the other clusters the importance of household income as a variable that explains travel-activity behavior. One of the unique features of this cluster is that while the other clusters are highly skewed in favor of one of the sex categories, this cluster (43.20% males, 56.80%

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females) is almost evenly distributed with exception to Cluster 4 (51.06% males, 48.94% females) which is evenly distributed. Another obvious result of the calibration is the absence of the mobility indices, TRANSFER and LT. This is expected since this cluster is dominated by non-trip makers which comprised 99.23% of the samples. What is doubtful however is the presence of EMP in the final model when in fact majority of the samples at 72.97% are unemployed. One reason cou d be day off from work. Lastly, the question that is answered here is not, 'What explains travel-activity behavior of an individual?' This is the question that is answered in Clusters 1, 2, 4, and 5. Rather, 'What explains non-tripmaking behavior?', is the question that is answered by the model in Cluster 3.

CLUSTER 4 - A total of fifty-seven (57) models were calibrated in this cluster. The variables in the final model are HH_INC*CAR_OWN*LIFE_CYC*AGE*LT with a ρ-value of 0.9887 way beyond the minimum of 0.10 and 0.35.

We have two groups of variables, socioeconomic characteristics and mobility indices. The first group can be further subdivided into two sub-groups, household and personal information. The household information in this study is composed of HH_INC, CAR_OWN and LIFE_CYC. Notice that in this cluster all three (3) household information variables came out into the final model. The presence of HH_INC is expected but the others have to be scrutinized first. TRANSFER was displaced for two (2) reasons: (1) TRANSFER and CAR_OWN are related to each other, though indirectly, hence a model can make do even without the other; (2) the same reasoning that we have in Cluster 1 that for a fixed trip such as school trips, an individual can not have both the luxury of convenience of travel, shorter LT and lesser TRANSFER. The presence of all three (3) household information is reinforced by results of other studies that what explains school trips are the household characteristics such as household income. The only personal information in the final model is the AGE variable which sounds logical that Elementary, High School and University students would probably have different travel-activity behavior depending on the household income. car ownership. and life-cycle of the household in question. Students belonging to high income households would probably have different travel-activity behavior compared to low income households. The presence of LT in the final model needs to be clarified. One consideration as to where to enroll the pupil or student is the distance of the school from home, and this sounds logical that parents will enroll them at the nearest school. LT was not meant to be a substitute for the capability of the pupil or student, but for convenience, the nearest school would probably be the preference. Another consideration is the household income. car ownership and life-cycle of the household in question which plays an important role of the choice of school and thereby the length of travel from home to school and vice versa.

CLUSTER 5 - A total of forty (40) models were calibrated in this cluster. This cluster is dominated by multiple trips. Of the 181 samples. only 3.87% or 7 samples, 2 males and 5 females does not belong to any of the employment categories. The model for this cluster is LIFE_CYC*OFFICE*TRANSFER*LT with a ρ-value of 0.6540.

Multiple trips can not be considered fixed neither is it non-fixed. A fixed trip has to be performed at a specific place and time while a non-fixed trip has to be done cyclically. For example. shopping might be done every four (4) days, church attendance on a weekly basis. medical at six-month interval. A multiple trip does not belong precisely in any of

the two. It can only be considered *random and cyclical*, i.e., it has some degree of randomness. It can not happen everyday, weekly, monthly, or semestrally. The important difference of this model from the others is the absence of HH_INC in the final model. While the HH_INC variable came out in the first four (4) models, it did not in this cluster. The presence of LIFE_CYC and OFFICE which probably assumed the role of HH_INC can be deduced from the definition of these variables in the footnote of Table 4. For example, a total of 63.54% of the cluster membership have flexible office time against the average of 18.07%. Regarding life cycle, it has the high~~t at 6.08% of its membership belonging to <u>household without disabled member and w;m a household help</u> against the average of 4.05%. The presence of the two mobility indices has to be investigated. First we argued that for a fixed trip, an individual can not have the luxury of having both conveniences of travel, shorter LT and lesser TRANSFER while for non-fixed trip, an individual can have both. While both Cluster 2 and Cluster 5 have TRANSFER and LT in the final model, the former (Cluster 2) has the option of availing the two options of shorter LT and lesser TRANSFER or it is considered a privilege but with Cluster 5, it is not an option but imposed by the very nature of the trip, i.e., multiple trips. If an individual performs multiple trips on a given day, he or she in all likelihood will make an itinerary such that the TRANSFER is lessened and LT shortened. Making an itinerary is like planning that trip and thereby runs counter to the randomness of multiple trips. The randomness here does not mean the type of trip but randomness means its occurrence.

TABLE 5

DETERMINANTS OF TRAVEL-ACTIVITY BEHAVIOR

DETERMINANTS OF TRAVEL-ACTIVITY BEHAVIOR		CLUSTER NUMBER					NO. OF TIMES
		1	2	3	4	5	
HOUSEHOLD INFORMATION	HH_INC						4
	CAR_OWN						1
	LIFE_CYC						2
SOCIO-ECONOMIC CHARACTE-RISTICS	AGE						3
	SEX						1
	DISAB						
PERSONAL INFORMATION	LICENSE						
	OCCU						
	EMP						3
	PER_INC						
	OFFICE						1
MOBILITY INDICES	TRANSFER						3
	LT						3
PROBABILITY		0.9997	0.9760	0.9590	0.9887	0.6540	

NOTE Shaded are determinants of travel-activity behavior

7.4 Summary

Household Income was found to be the most important variable that explains travel-activity behavior in the **household information** group. For the **personal information** group. Age and Employment were found to be the most important variables in explaining travel-activity behavior. For the **mobility indices**, both TRANSFER and LT are important determinants of travel-activity behavior. By cluster, it was found that the most important determinants of travel-activity behavior for the cluster dominated by students are the household information or the household characteristics. See Table 5 above.

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8.0   SUMMARY AND CONCLUSIONS

8.1   Introduction

The study aims to identify a representative travel-activity pattern for the 21.9 million daily trips in Metro Manila and analyze the socioeconomic characteristics of these groups of individuals who undertake the same type of travel-activity behavior. We also intend to identify what the mobility indices that an individual would likely consider when he or she undertakes urban activities.

8.2   The Representative Travel-activity Patterns

In this study, we found that indeed there are representative travel-activity patterns of the 21.9 million daily trips in Metro Manila. The five (5) major travel-activity patterns in Metro Manila are the following:

Cluster 1 - The travel-activity pattern represents 24.47% of the samples. The cluster spent the least time at home at 749 minutes and spent the most time at work at 537 minutes among the five (5) clusters. The average travel time is 133 minutes.

Cluster 2 - The travel-activity pattern represents 27.52% of the samples. Most of the activities outside of home (1.206 minutes) were eating and shopping (44 minutes), medical and social (34 minutes), others (22 minutes), private business (20 minutes), school (14 minutes), employer's business (13 minutes), and church (6 minutes) activities. The average travel time is 66 minutes.

Cluster 3 - The travel-activity pattern represents 19.66% of the samples. Most of the activities were spent at home at 1.439 minutes or practically the whole day.

Cluster 4 - The travel-activity pattern represents 25.30% of the samples. The dominant activity types outside of home (965 minutes) were school at 414 minutes and travel time (57 minutes) while eating and shopping and medical and social activities are less significant.

Cluster 5 - The travel-activity pattern represents 3.04% of the samples. This cluster is dominated by multiple trips with employer's business as the dominant activity types at 510 minutes outside of home (755 minutes) and 32 minutes time spent at work. The average travel time is 129 minutes, the longest among the five (5) clusters.

8.3   Summary and Conclusions

Table 6 below gives the summary of the five (5) representative travel-activity patterns for the 21.9 million daily trips in Metro Manila which includes socioeconomic characteristics such as age, employment and occupation and their corresponding percentages and the dominant travel-activity types these groups were performing during the survey day. The determinants of travel-activity behavior were divided into three (3) groups, i.e., the household information (HI), personal information (PI) and the mobility indices (MI).

TABLE 6

SUMMARY OF THE CLUSTERS

CLUS-TER NO	NO OF SAM-PLES (%)	AVE AGE	SOCIOECONOMIC CHARACTERISTICS EMPLOYMENT OR OCCUPATION	LT (KM)	DOMINANT TRAVEL-ACTIVITIES TYPE / (%)	DETERMINANTS OF TRAVEL-ACTIVITY BEHAVIOR	DESCRIPTION
1	1,455 / 24.47%	33.96	**EMPLOYMENT** MANUFACTURING = 19.18% WSALE & RETAIL TRADE = 17.53% CONSTRUCTION = 9.35% TRANS. STORAGE & COMM = 9.00% PUB. ADM. & DEFENSE = 7.49% Employed = 94.98%	35.49	HM 51.88% WRK 37.29% SCH 0.63% NON-FIXED 0.97% TRAV TIME 9.24% / 100%	*H.I.* HH INCOME *P.I.* AGE EMPLOYMENT *M.I.* TRANSFER	MOSTLY WORK TRIPS, LONG LT & VERY HIGH EMPLOYMENT RATE
2	1,636 / 27.52%	34.47	**EMPLOYMENT** WSALE & RETAIL TRADE = 16.69% Employed = 38.26% **OCCUPATION** HOUSEWIFE = 31.66% OFF. OF GOVT., MNGRS SUPVSRS = 16.87% JOBLESS = 15.28% ELEMENTARY STUDENTS = 8.25% LABRS. & UNSKILLED WKRS = 7.40%	27.25	HM 83.75% WRK 0.97% SCH 0.97% NON-FIXED 9.72% TRAV TIME 4.58% / 100%	*H.I.* HH INCOME EMPLOYMENT *M.I.* TRANSFER LT	MOSTLY NON-FIXED TRIPS, MEDIUM LT & LOW EMPLOYMENT RATE
3	1,169 / 19.66%	33.91	**EMPLOYMENT** Employed = 27.03% **OCCUPATION** JOBLESS = 27.46% HOUSEWIFE = 25.66% OFF. OF GOVT. MNGRS SUPVSRS = 10.18% OTHERS = 10.18% ELEMENTARY STUDENTS = 6.50% LABRS. & UNSKILLED WKRS = 6.33%	0.18	HM 99.93% WRK nil SCH nil NON-FIXED nil TRAV TIME nil HM 100%	*H.I.* HH INCOME *P.I.* AGE SEX EMPLOYMENT	MOSTLY NO TRIPS, VERY LOW LT & LOW EMPLOYMENT RATE
4	1,504 / 25.30%	12.81	**EMPLOYMENT** Employed = 0.86% **OCCUPATION** ELEMENTARY STUDENTS = 52.26% HIGH SCHOOL & UNIVERSITY STUDENTS = 46.61%	11.86	HM 67.08% SCH 28.75% NON-FIXED 0.21% TRAV TIME 3.96% / 100%	*H.I.* HH INCOME HH CAR-OWN LIFE CYCLE *P.I.* AGE *M.I.* LT	MOSTLY SCHOOL TRIPS, LOW LT & VERY LOW EMPLOYMENT RATE
5	181 / 3.04%	37.65	**EMPLOYMENT** TRANS. STORAGE & COMM = 41.99% WSALE & RETAIL TRADE = 24.31% Employed = 96.13%	57.42	HM 52.50% WRK 2.22% SCH 0.07% NON-FIXED 36.25% TRAV TIME 8.96% / 100%	*H.I.* LIFE CYCLE *P.I.* OFFICE *M.I.* TRANSFER LT	MOSTLY MULTIPLE TRIPS/ EMPLOYER'S BUSINESS, VERY LONG LT & VERY HIGH EMPLOYMENT RATE

Note: The other employment or occupation categories were not listed because its contribution to the cluster composition is negligible.

The most important variables that explains travel-activity behavior of an individual are the Household Income while LT, TRANSFER, Employment & Age follow. The students' travel-activity behavior is strongly influenced by his or her household characteristics. The general type of trips are Fixed Trips, Non-Fixed Trips and Multiple Trips. For a non-fixed trip, the two (2) mobility indices LT and TRANSFER are being considered but for a fixed trip, only one of the mobility indices is being considered while for non-trip makers, no mobility index is being considered in the travel-activity decision-making process of the individual.

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