

# AN ACTIVITY BASED CHARACTERISTIC STUDY ON TRAVEL BEHAVIOR OF RURAL MIDDLE CLASS RESIDENTS

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**Abstract:** Mode choice behavior is a fundamental element of travel behavior that has significant implications for transportation planning and management. It is the demand for activities that produces the demand for travel. In other words the need or desire to engage in an activity at a different location generates a trip. So, once we understand how activities are engaged in the course of a day or a week, a rigorous understanding of travel demand will follow. This paper deals with the study of the travel behavior of rural middle class residents. So in this study we use the activity based approach to predict the travel behavior based on a thorough understanding of the decision process underlying travel behavior. The data for the analysis is collected using household travel survey. The study area selected is a rural village in Ernakulam district of Kerala, India. The total mode share includes walk, bicycle, auto rickshaw, two-wheeler, car and bus in which two wheelers form the major share. The data has been analyzed using Statistical Package for Social Sciences (SPSS).

**Keywords:** Activity based approach, Mode choice, SPSS, travel behavior

## I. INTRODUCTION

Since the beginning of civilization, the viability and economic success of communities have been, to a major extent, determined by the efficiency of the transportation infrastructure. However, over the past few decades, triggered by socio-economic changes, travel behaviour has changed considerably. Trip making behaviour becomes more spatially and purpose-wise complex, and hence the flexibility of travel mode becomes more important. Mobility services offered by public transport are less attractive. This has resulted in an increase in private vehicles such as car and two-wheeler ownership. India is experiencing many of the problems associated with increasing private vehicle dependence. Travel is one of many attributes of an activity. In the conventional approach, activity attributes such as the mode used and travel time consumed in accessing an activity are treated as travel attributes and are the focus of descriptive and predictive models. From this perspective, conventional trip-based models are simply a special case of activity-based approaches. Travel is essentially a physical mechanism to access an activity site for the purpose of participating in some activity. So this study is an effort to understand the mode choice behaviour of rural residents based on activity based approach.

## II. LITERATURE REVIEW

Activity-based approach was conceived in the 1970s by a group of researchers at Oxford University. This approach aims at the prediction of travel demand based on a thorough understanding of the decision process underlying travel behaviour. As the activities engaged in a day are linked to each other, trips made to pursue them are also linked to each other; they cannot be analysed separately one by one. Analysis of activity and travel characteristics shows the importance of mode choice in any activity-travel decision. The tendency of households to optimize their activity pattern in such a way that trips for different motives can be combined to chains has been a phenomenon of since 1970s [1]. The basic hypothesis is that a household participate in all kinds of non-home activities to meet their various needs by trips and balances the desire to meet each need as it arises with the transportation expenditures required in travel. Since travellers often chain multiple activities together in a trip chain for greater efficiency and convenience, the influence of trip chain on mode choice was considered [8] by classifying trips to single trip, simple trip chain and complex trip chain. The challenge of realistically modelling “minor” modes, while maintaining behavioural realism in the rest of the model was undertaken by simulating household interactions [6]. The relationship between mode choice and the complexity of trip chaining patterns of travel behaviour was also represented [16].

### III. STUDY AREA

The rural area selected for data collection is Varappetty Panchayat which is a village in Kothamangalam Taluk of Ernakulam district in the Indian state of Kerala. It is 4.8 km distance from its Taluk main Town Kothamangalam which is known as the Gateway of High range and is 37.2 km from its District Main City Kochi 175 km from its state main city Thiruvananthapuram.

### IV. DATA COLLECTION

For developing the activity based mode choice model, the middle class residents of the study area are interviewed with emphasis given to previous day's travel pattern (for the whole day) of every member of the family concerning household details, personal details and trip details. The total data set comes to of 602 (from 153 households) including both trips and non trips. Out of the 602 sample population 174(28% of total) are without any trip data. Within the remaining 427 population 120(20% of total) is with multiple trips and thereby the total data set come to 596 in number.

### V. SOCIO ECONOMIC CHARACTERISTICS

Fig.1 shows the mode usage in the study area.

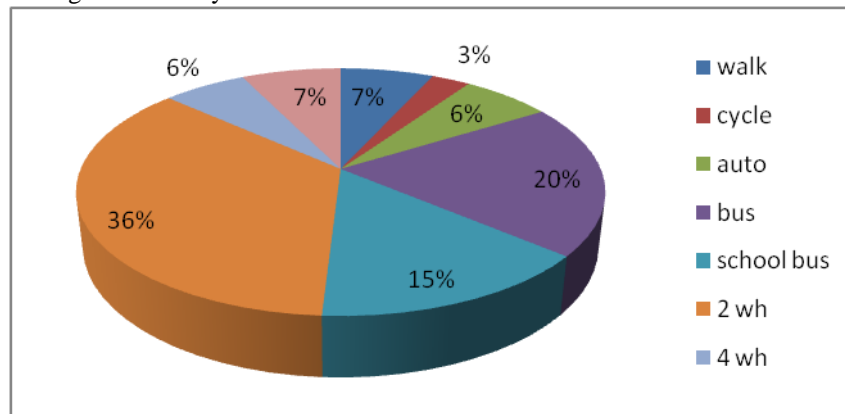


Fig.1 Mode usage in the study area

- 1) Sample population consists of 50% male and 50% female which satisfies the census data 2012.
- 2) About 58% of the sample population comes under the working group of age between 21 and 60.
- 3) 79% of the sample population forms the lower middle class community.
- 4) Within the sample only 39% hold a license which is justifiable for a rural area.
- 5) When the sample is analyzed based on occupation, about 39% are the non working (NW) group (consisting of infants, house wives and people of age more than 60). When the school and college going students are also added, the actual non working category comes about 63%. Among the working group majority is the self employed group 24% of total, which is 64 % of the total working community. Here the government employees are only 5% of total which is 14% of the working community, gives a clear indication about a rural area.
- 6) About 58% of total sample population are two wheeler owners and next comes the four wheeler ownership and this itself is reason for the increased two wheeler trips.
- 7) Bus is the most frequently used mode and comes around 39%, which is a characteristic of the rural middle class community's travel pattern. 35% of the people use two wheelers as their frequent mode for travel.
- 8) Considering the trip purpose work trips and educational trips are the most frequent trips with 36% and 35% of total trips. Shopping and leisure trips are the least frequent trips which are only 4% of total trips.
- 9) Majority of the trips (93%) are single modal trips although there are few (7%) multimodal trips due to less frequency of public transport in the area.
- 10) Almost 28% of people do not travel frequently and 52% are with only one trip per day. But there are 20% of people who travel more than one time in a day.

### VI. EFFECT OF VARIABLES ON MODE CHOICE

From Table 1 showing the effect of household size (HHS) on mode choice it can be inferred that house hold size has no significant effect on mode choice because mostly in every mode the highest percentage is shared by household size four, which is the average household size in the rural area consisting of father, mother and two children.

TABLE 1  
EFFECT OF HOUSEHOLD SIZE ON MODE CHOICE

HHS	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
1	0.0%	0%	10.7%	0.0%	0.0%	1.3%	0.0%	3.2%
2	3.4%	8.3%	7.1%	7.1%	1.6%	12.5%	7.7%	9.7%
3	24.1%	16.7%	10.7%	5.9%	6.3%	23.0%	11.5%	9.7%
4	10.3%	41.7%	35.7%	41.2%	31.7%	30.3%	38.5%	51.6%
5	31.0%	8.3%	17.9%	25.9%	34.9%	23.0%	42.3%	16.1%
6	20.7%	16.7%	17.9%	15.3%	15.9%	5.9%	0.0%	6.5%
> 6	10.3%	8.3%	0.0%	4.7%	9.5%	0.0%	0.0%	3.2%

Table2 shows that of people using two-wheelers, 84% are males which are a characteristic of rural area and out of those using bus, and 60% are females. Though the population consists of equal proportion of males and females, a decrease in female share is evident in each mode usage because the female population trip in lesser number than the male population which is a characteristic of the rural area.

TABLE 2  
EFFECT OF GENDER ON MODE CHOICE

GENDER	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
MALE	62.1%	91.7%	75.0%	40.0%	39.7%	83.6%	53.8%	54.8%
FEMALE	37.9%	8.3%	25.0%	60.0%	60.3%	16.4%	46.2%	45.2%

Majority of people using modes like walk, cycle, three-wheeler, bus and school bus are having no license, as per table3.

TABLE 3  
EFFECT OF LICENSE ON MODE CHOICE

LICNS	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
NO	75.9%	66.7%	57.1%	68.2%	96.8%	9.2%	57.7%	45.2%
YES	24.1%	33.3%	42.9%	31.8%	3.2%	90.8%	42.3%	54.8%

Table 4 shows that there is significant effect of four-wheeler ownership on mode choice since of those choosing walk, cycle, three- wheeler or bus as their travel mode, 75% does not own a car.

TABLE 4  
EFFECT OF FOUR WHEELER OWNERSHIP ON MODE CHOICE

FOUR WHEELER OWNERSHIP	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
NO	62.1%	75.0%	75.0%	69.4%	54.0%	52.0%	11.5%	58.1%
YES	37.9%	25.0%	25.0%	30.6%	46%	48.0%	88.5%	41.9%

As per table 5, the effect of household annual income on mode choice is not significant. The main reason is that in developing countries, lower middle income, LMC (annual income between 2.5 to 6 lakhs) people form the majority of population in the rural areas.

TABLE 5  
EFFECT OF HOUSEHOLD ANNUAL INCOME ON MODE CHOICE

ANNUAL INCOME	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
LMC	86.2%	91.7%	92.9%	83.5%	71.4%	75.0%	65.4%	74.2%
UMC	13.8%	8.3%	7.1%	16.5%	28.6%	25.0%	34.6%	25.8%

No significant effect for number of household school children (HHSC) on mode choice as per table6 and the average number of school going children in rural families is two.

TABLE 6  
EFFECT OF NUMBER OF HOUSEHOLD SCHOOL CHILDREN ON MODE CHOICE

HHSC	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
0	44.8%	58.3%	39.3%	34.1%	0.0%	53.9%	73.1%	45.2%
1	13.8%	25.0%	17.9%	27.1%	34.9%	21.7%	19.2%	9.7%
2	37.9%	16.7%	35.7%	32.9%	55.6%	21.1%	7.7%	45.2%
3	3.4%	0.0%	7.1%	5.9%	9.5%	3.3%	0.0%	0.0%

From table 7 it is inferred that in agriculture-based rural areas the household college students (HHCL) will very rarely one or usually be zero since, people after 18 years will be going for job and is a characteristic of the rural area.

TABLE 7  
EFFECT OF NUMBER OF HOUSEHOLD COLLEGE STUDENTS ON MODE CHOICE

HHCL	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
0	89.7%	83.3%	96.4%	68.2%	95.2%	79.6%	92.3%	77.4%
1	6.9%	16.7%	3.6%	30.6%	4.8%	18.4%	7.7%	19.4%
2	3.4%	0.0%	0.0%	1.2%	0.0%	2.0%	0.0%	3.2%

Table 8 shows that almost all the middle class families in the rural area has got at least one two-wheeler (2 WH).

TABLE 8  
EFFECT OF TWO-WHEELER OWNERSHIP ON MODE CHOICE

2 WH	MODE							
	WALK	CYCLE	3 WH	BUS	SC BUS	2 WH	4 WH	MULTI MODE
0	6.9%	0.0%	32.1%	8.2%	4.8%	1.3%	7.7%	12.9%
1	82.8%	100.0%	67.9%	81.2%	81.0%	69.1%	80.8%	74.2%
2	10.3%	0.0%	0.0%	10.6%	14.3%	27.6%	11.5%	12.9%
3	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%

## VII. EFFECT QUANTIFICATION

The factors which were found influencing the mode choice of rural residents were four-wheeler and three-wheeler ownership, license ownership, total trip walking time, waiting time, cost and duration. The results obtained after the multinomial logistic analysis using SPSS are given in Table 9.

TABLE 9  
 PARAMETER ESTIMATES

TR_MODE		B	Sig.	Exp(B)
4 WH	intercept	-.723	.511	
	TR_CT	.101	.000	1.107
	TR_DRN	-.048	.002	.953
	4WH=NO	-3.129	.005	.044
	LICNS=NO	2.827	.000	16.893
3 WH	intercept	-1.529	.051	
	TR_CT	0.083	.000	1.086
	TR_DRN	-0.019	.034	.981
	4WH=NO	1.267	.042	3.55
	3 WH=NO	-3.901	.000	.02
	LICNS=NO	4.29	.000	72.96
MULTI MODE	intercept	-5.62	.001	
	TR_WTT	1.183	.000	3.265
	TR_CT	.055	.001	1.057
	4WH=NO	2.092	.015	8.102
	LICNS=NO	3.963	.000	52.616
SCHOOL BUS	intercept	-5.427	.018	
	TR_WKT	.368	.001	1.445
	LICNS=NO	7.535	.000	187.182
BUS	intercept	-3.9	.029	
	TR_WTT	1.705	.000	5.504
	LICNS=NO	2.903	.011	18.227

- 1) Of attributes of traveller variables, a negative constant of all the modes considered other than two wheeler accounts for the unobserved factors to be in the negative direction of choosing these modes compared to two-wheeler. In other words unobserved factors influence positively to prefer two-wheeler than any other mode.
- 2) The significant factors that influence the choice between four-wheeler and two-wheeler are travel cost, travel duration, four wheeler ownership and license holding. Considering the choice between three-wheeler and two-wheeler another factor three-wheeler ownership also comes into effect. For multimode selection trip waiting time is an additional influencing factor. For school bus as travel mode only walking time and license holding matters and for bus waiting time and license ownership affects the choice.
- 3) Travel cost has a positive influence on four-wheeler, three-wheeler and multi mode when compared with two-wheeler.
- 4) Trip duration has a negative influence on choosing four-wheeler and three-wheeler than two-wheeler.
- 5) People who have no four-wheeler ownership, has a negative influence on choosing four-wheelers than two-wheelers compared to those having four-wheeler ownership. The same is the case with choosing three-wheelers compared to two-wheeler between those without and with three-wheeler ownership. But there is a positive influence on choosing three-wheeler and multi mode than two-wheeler compared to those having four-wheeler ownership.
- 6) The variable no license has a positive influence on all modes compared to two wheelers than those who hold a license.
- 7) The value of Exp (B) is 18.227 for bus mode, which is >1 implies that for each unit increase in no license the odds are increased in choosing bus as mode.
- 8) The value of Exp (B) is 0.981 for three-wheeler mode, which is <1 implies that for each unit increase in no three-wheeler ownership the odds are decreased in choosing three wheeler as their mode by  $(.981-1=-.019=1.9\%)$ .

## VIII. CONCLUSION

This paper is a characteristic study on the travel behaviour of rural middle class residents using activity based approach. The study helped to draw the socio economic as well as mode choice characteristics of a typical agriculture based rural village area. The activity based approach really helps to study the travel pattern in a realistic way. The empirical analysis used the data collected by means of household survey of every individual of the middle class family and software tool SPSS was used to develop the model. four-wheeler and three- wheeler ownership, license ownership, trip walking time, waiting time, cost and duration were found to be the most influencing factors for the choice of mode. The scope of the study is that it could greatly help the policy makers and will be the area of interest for public transport service providers who are interested in attracting choice riders.

## REFERENCES

- [1] Bowman. J.L. And Ben-Akiva. M.E., activity based travel demand model systems.
- [2] Bowman. J.L and Ben-Akiva. M.E., "Activity-based disaggregate travel demand model system with activity schedules", Transportation Research Part A 35: 1-28, 2000.
- [3] Cheryl Stecher, The Franklin Hill Group, Santa Monica, CA, USA and Rahaf Alsnih, "Standards For Household Travel Surveys – Some Proposed Ideas", Institute of Transport Studies, The University of Sydney, Australia.
- [4] Chandra R. Bhat, Frank S. Koppelman, "Activity-Based Modeling of Travel Demand".
- [5] Eric J. Miller, Matthew J. Roorda & Juan Antonio Carrasco, "A tour-based model of travel mode choice", Transportation 32: 399–422, 2005.
- [6] Matthew J. Roorda, Dylan Passmore, and Eric J. Miller, "Including minor modes of transport in a tour-based mode choice model with household interactions", Journal of Transportation Engineering, Vol. 135, No. 12, December 1, 2009.
- [7] Md. Tazul Islam, "Unraveling the Relationship between Trip Chaining and Mode Choice using Structural Equation Modeling". University of Alberta, 2010.
- [8] Meiping YUN, Jiangyong LIU, Xiaoguang YANG. "Modeling on Mode Choice Behavior Based on Trip Chaining: A Case Study in Zhongshan City", ICCTP 2011 © ASCE 2011.
- [9] Michael G. McNally and Craig R. Rindt, "The Activity-Based Approach", Institute of Transportation Studies University of California, 2007.
- [10] Omer Khan, "Modeling passenger mode choice behavior using computer aided stated preference data". School of urban development, Queensland University of technology, 2007.
- [11] Peter R. Stopher, Institute of Transport Studies, The University of Sydney, Australia, Chester G. Wilmot, Department of Civil and Environmental Engineering and Louisiana Transportation Research Center, Louisiana State University, Baton Rouge, LA, USA.
- [12] Roorda, M. J., Carrasco, J. A., and Miller, E. J., "An integrated model of vehicle transactions, activity scheduling and mode choice." Transportation Research, Part B: Methodological, 43(2), 217–229, 2009.
- [13] Ryuichi Kitamura, "Applications of Models of Activity Behavior for Activity Based Demand Forecasting", Graduate School of Engineering Kyoto University, 1996.
- [14] Subbarao SSV and Krishna Rao KV, "Analysis of Household Activity and Travel Behavior: A Case of Mumbai Metropolitan Region". International Journal of Emerging Technology and Advanced Engineering. Volume 3, Issue 1, January, 2013.
- [15] Thomas Adler and Moshe Ben-Akiva, "A theoretical and empirical model of trip chaining behavior", Transportation Research part B Vol. 13B, pp. 243-257, 1978.
- [16] Ye, X., and Pendyala, R. M, "An exploration of the relationship between mode choice and complexity of trip chaining patterns." Transportation Research Part B: Methodological 41 (1): 96-113, 2007.
- [17] Zhaoming CHUI Lin CHENG and Hui CHEN, "A Review of Activity-Based Travel Demand Modeling", CICTP 2012 © ASCE 2012.