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Modeling of Discretionary Activities of Non-Workers in a City in India

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Abstract

This paper concentrates on the decision of non-workers to participate in shopping and recreation in Calicut city, a major urban center in Kerala, in India. The non-workers in the present study comprise of homemakers and the retirees. Activity and travel details collected using home interview survey formed the data base for the study. Multinomial logit models are used for analyzing the participation behaviour of non-workers in these activities. Age, travel mode, availability of household vehicles, presence of school going children, day of the week and time of day are some of the variables influencing these choices. The outcome confirms the previous findings on factors affecting non-work participation behaviour of non-workers in these activities. These models have wide applicability in determining the travel behaviour of non-workers and can serve as a major input to travel demand forecast.

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1. Introduction

Travel is an indirect demand that arises from the needs of individuals to pursue different activities. It is very essential to ensure ones participation in various activities. Modelling of participation behaviour of any individual is

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essential for analyzing the travel behaviour and a major input to travel demand. Travel behaviour models should be developed by categorizing the entire population into groups with similar characteristics. This is necessary because the characteristics and duties of individual make them different from each other.

The models of activity travel behaviour analysis are plenty in developed countries, but very few studies attempted to model activity travel behaviour of individuals in the developing economies. Compared to the activity behaviour of workers little attempt had been given on travel analysis of non-workers, which can be a major input to the travel demand and transportation planning process. Also the accessibility and mobility requirements of non-workers are different from the working communities and the temporal fixities are less, this offers the non-workers more flexibility to participate in various activities.

The present work models the shopping and recreation of homemakers and retirees. These models consider all details of trips, activities, mode, place and time at which these activities are performed and the time taken for each activity engagement, along with the characteristics of individual and household. It requires an analysis of the complete sequence of activities engaged by each individual on the whole day. The non-workers who participate in at least one discretionary activity like shopping or recreation along with other activities is considered for modelling. Simple and complex activity pattern is used in the study. A simple activity pattern consists of only one activity engagement namely home-shop-home (H-S-H) or home-recreation-home (H-R-H). The complex pattern considered in the study is home-shop-other-home (H-S-O-H). A similar pattern is considered for recreation also.

1.1. Literature review

The literature pertaining to the analysis of travel behaviour of workers using activity based model have received extensive analysis and research [1] [2] [3] [4] [5] [6] [7]. Majority of the earlier work on activity-based research literature pertains to developed countries like the United States of America. Different methodologies were also developed by various researchers for modelling the various decisions to participate in activities. These models include binary logit models [8][9][10], regression models [11], probit models [12] and multinomial logit models [9]. The factors influencing these decisions were identified as household assets, presence of small children [10] [13] gender, age, education level, household size and number of workers [14]. Difference in travel behaviour of workers and non-workers were identified by [15] and [16]. Time budgets of non-workers in India are found to be different from workers in the developed world. [17] [18] understood that age and household size were not found to influence the travel time in the Indian city, and they explored the relationship between non-work activity duration of adult individuals in a household composed of two adult families in a city in India. The recent work on non-workers activity participation was done by [19] using a structural equation model. The present work considers different categories of non-workers including day of the week as a variable. In addition a wide variety of indirect variables were also incorporated in the model development. The interaction effects were also included in the model using certain dummy variables.

2. Study area and data collection

2.1. Study area

Calicut is one of the medium sized cities in Kerala in South India. It is located on the west coast of India. According to the 2011 census, the population of Calicut city is 6.022 lakhs and a population density of 5104 inhabitants per square kilometer. There are three national highways, NH-17, NH-212, and NH-213 passing through the city, which gratify to the main activity system of the city. The study area contains 71 electoral wards as per 2011 census.

2.2. Data collection

Home interview survey was conducted for data collection, using an activity travel diary that consisted of household information, personal information, and activity travel details. Details of every individual in the household were

collected from 9900 households in various zones of the city. A pilot survey was done in the beginning, to ensure the efficiency of the questionnaire based on the response rate and then the format was finalized.

A descriptive analysis of some of the household, personal and travel variables obtained from the sample were also carried out to understand the general characteristics of the area. The average household size in the city is 4. Non-workers comprises of homemakers, retirees and the students. Number of unemployed adults is more than the average number of workers in the family. Average number of cars per household is 0.42 and two wheelers is 0.85. The analysis of the occupational status was made to understand the general trend of people choosing occupation, and the educational status of the sample population. It is also done to understand the prominent group in the sample and their occupation. Data exploration reveals that in the sample data about 31% of the people are employed and 32% are homemakers. Students make up 24% of the population, retired persons and the persons seeking employment area are respectively 6% and 2%.

3. Modeling Methodology

Multinomial logit model is used to model the simultaneous decision of non-workers. MNL model is the most popular discrete choice model for practical applications. Step-wise procedure was adopted for model development and the best-fit model obtained is presented. The choice set for shopping model of homemakers include the decision not to participate in shopping, decision to participate only in shopping and decision to participate in shopping in addition to other trips. The eqn. 1 shows the multinomial logit model representing the general expression for the probability of choosing an alternative from a set of alternatives proposed by [20].

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

$P_n(i)$ is the probability of the decision-maker choosing alternative 'i' V_j is the systematic component of the utility of alternative 'j'.

Table 1. Variables selected for the final model.

Variable	Description
PCGS	1 if there are at least one college going children in the household; 0 otherwise
PINF	1 if there are at least one child with age less than 4 years in the household; 0 otherwise
NST	Number of students in the household
HHSIZE	Number of members in the household
NEMP	Number of employees in the household
HHINC	Household income in rupees
POLD	1 if there are at least one person above 80 years in the household; 0 otherwise
GEN	1 if the individual is male; 0 otherwise
AGE	Age of individual in years
TWCH	1 if mode used for travel is two wheeler; 0 otherwise
BUSCH	1 if mode used for travel is bus; 0 otherwise
TD	Distance travelled for work in Km
SHRIDE	1 if the individual shared travel cost with someone; 0 otherwise
STARTEV	1 if the person travelled for an activity during evening; 0 otherwise
STARTLM	1 if the person travelled for an activity during late morning; 0 otherwise
STARTAN	1 if the person travelled for an activity during afternoon; 0 otherwise
STARTLAN	1 if the person travelled for an activity during late afternoon; 0 otherwise
STARTEP	1 if the person travelled for an activity during evening peak; 0 otherwise
NAUTO	Number of household automobiles
SZ	1 if the residence and activity locations are same ; 0 otherwise
DUR	Time taken for an activity in minutes

Table 1 presents the list of variables in the final model specification. The dummy variables were used to specify the gender, age, mode used, shared ride and presence of college going children in the household.

3.1. Model specification

The model fitness is assessed using statistical measures, namely, t-statistic, level of significance, chi-squared value, model predictability, and adjusted likelihood ratio index (ρ^2). The initial log likelihood value is a measure of a model with no independent variables, i.e. only a constant or intercept. The final log likelihood value is the measure computed using all variables that have been entered into the model. The rho-squared value is used to describe the overall goodness of fit of the model and is given in eqn. 2

$$\rho^2 = 1 - \frac{LL(\beta)}{LL(c)} \tag{2}$$

where $LL(c)$ = log-likelihood for the constant only model and $LL(\beta)$ = log-likelihood for the estimated model.

4. Model development

Activity participation models are developed for homemakers and retirees for shopping and recreation. Activity participation models for homemakers were developed based on 1334 samples of this category. The retirees in the sample population were 825. Two third of the data was used for calibration and one third for validating the model. The model for participation behaviour of non-workers shopping activity is shown in table 2.

Table 2. Shopping participation model for non-workers.

Alternative	Variable	Homemakers	Retirees
Const	Simple	0.998 (2.696)	0.150 (0.443)
	Complex	-2.179 (-1.688)	-34.892 (1.000)
simple	PINF	-0.350 (-1.283) ^c	
	HHSIZE	-0.205 (-3.725) ^a	
	PCGS	0.456 (2.213) ^b	
	AGE	-0.010 (-1.861) ^c	
	TD	-0.045(-1.813) ^c	-0.124 (-3.448) ^a
complex	SHRIDE		0.570 (3.229) ^a
	STARTEV	-0.889 (-2.334) ^b	
	HHINC	0.023 (2.914) ^b	
	POLD	-1.386 (-2.141) ^b	
	NWDUR	-0.009 (-2.466) ^b	
	FRIDAY	1.069(2.061) ^b	
	Log-likelihood for constant only model	-669.275	-583.880
	Log-likelihood at convergence	-616.799	-548.537
	Chi-squared	104.951	70.687
	Adjusted R-squared	0.176	0.158
	Percent correctly predicted	66.48	68.43
	N	940	550

Notes: ^aSignificant at 0.01 level. ^bSignificant at 0.05 level. ^cSignificant at 0.1 level

Models to understand the participation behaviour of non-workers recreation activity is shown in table 3. Various household, personal activity and travel variables were found to influence recreation. The model prediction in each case was about 65%.

Table 3. Recreation participation models for non-workers.

Alternative	Variable	Homemakers	Retirees
Const	Simple	-1.901(-4.665)	-1.505(-3.904)
	Complex	1.777(1.496)	-1.675(-2.233)
	HHSIZE	0.223(3.008) ^a	
	HHINC	0.011(3.099) ^a	
	NAUTO	0.028(2.157) ^b	
	AGE	0.008(2.027) ^b	
	GEN	0.445(2.207) ^b	0.601(2.273) ^b
	DUR	0.006(5.231) ^a	
	TD	-0.100(-4.138) ^a	
	TWCH	0.602(2.998) ^b	
Simple	SZ	-0.544(-2.930) ^b	
	STARTLM	1.164(3.490) ^a	
	STARTEP		0.556(1.819) ^b
	BUSCH	0.374(2.563) ^b	0.435(2.059) ^b
Complex	NST	0.374 (2.282) ^b	
	SHRIDE	0.847(2.443) ^b	
	STARTAN	-3.099(-3.948) ^a	
	STARTLAN	-1.681(-2.232) ^b	
Log-likelihood for constant only model		-1110.788	-659.709
Log-likelihood at convergence		-968.555	-641.172
Chi-squared		284.465	37.073
Adjusted R-squared		0.126	0.127
Percent correctly predicted		65.351	66.033
N		940	550

Notes: ^aSignificant at 0.01 level. ^bSignificant at 0.05 level. ^cSignificant at 0.1 level

4.1. Modeling results and discussions

The homemakers and retirees are more likely to perform simple activity pattern for shopping. Presence of infants is having a negative influence on home maker's decision to participate in shopping activity. Household size negatively influences the propensity of homemakers to participate in shopping while presence of college going students increases the likelihood to participate in this activity. As age increases, homemakers are less likely to participate in shopping and they are less likely to participate in shopping during the evening hours. Household income influences the propensity of homemakers to participate in complex activity pattern for shopping. The number of old people in the household restricts the homemakers to make more trips for shopping. If the duration for shopping is more the homemaker is less likely to perform a complex activity pattern for shopping. The day of the week also influences shopping participation. The homemakers are more likely to participate in complex activity pattern on Fridays. As distance increases; they are less likely to participate in shopping.

Late evening hours are preferred by retirees for engaging in shopping. There is no effect of household or personal variables on shopping participation of retirees.

The homemakers are more likely to perform complex pattern for recreation. The model reveals the effect of household size, household income and number of automobiles to positively influence the decision to participate in recreation. The personal variable age and gender influences the decision for recreation. Aged people are more likely to perform simple pattern for recreation and males are likely to perform simple pattern for recreation. Among the activity-travel variables, when the duration is more the homemakers are less likely to make a complex pattern. Two-wheeler and bus are the preferred mode for recreational travel.

The household variables affecting the homemaker’s decision for complex pattern for recreation is number of students. Homemakers are more likely to perform shared ride for complex pattern. Afternoon and late afternoon hours are not chosen for participating in recreational activities. Day of the week is not having any effect on the homemaker’s decision to participation in recreation.

Retires are more likely to perform simple activity pattern for recreation. The effect of personal variables shows that males are more likely to participate in recreation activity compared to females. Among the activity-travel variables, effects of the dummy variables corresponding to the mode bus are positive and significant for recreation for both home makers and retirees.

4.2. Model application

The results presented in the paper are very useful for policy implications in Calicut city. The application of the model is applied to understand the travel behaviour of homemakers participating in recreation. For the purpose of policy analysis the increase in recreation trips is implemented by randomly selecting 20% of the homemakers who perform simple trips for recreation. These trips are then randomly converted into complex trips. The original distribution of recreational trips in the sample with simple pattern is 529 (38%) and complex is 49 (3.5%) and other trips 816 (58.5%). After implementing the increase in complex trips, the new distribution are as follows simple trips 423 (28%) and complex 156 (13.5 %) trips and other trips are 816 (58.5%).

Table 4. Policy analysis for homemaker’s recreation.

Type of activity	Percentage change in pattern due to a decrease in 20% Two-wheeler choice
Simple	-21
Complex	34
Other trips	-23

The increase in choice for bus is reflected by a decrease in usage of two wheeler choice and designating them as transit users. The original number of two wheeler users is 90 (20.92%) and bus users are 307 (79.10%), with the change two wheeler users and bus users are 72 (16.7%) and 325 (75.5%). The reduction in the usage of two-wheelers causes a reduction in the recreation participation by 21% and other trips by 23%. This reduction results in the increase of complex trips by 34% which is a high value.

5. Conclusion

The influence of various household, personal, activity and travel variables was reflected in the model developed. One of the major finding is the influence of day of the week on participation behaviour of home makers in shopping and recreation. There is no influence of day of the week on retiree’s participation in these activities. Time of the day was found to affect the various choices made by the non-workers. Presence of infants and household size restrict the homemakers from making more shopping participations due to the familial responsibilities and the special characteristics of people in Calicut city. Retirees prefer joint ride for shopping. Homemakers are more likely to perform complex pattern for shopping on Fridays. Day of the week was not found influencing the activities of the retirees.

Among the non-worker the males are more likely to participate in non-work activities. Public transportation is preferred by both homemakers and retirees participating in recreation. This is a major finding and reflects the need for public transportation improvements in the city. These findings can be useful to predict the impact of public transportation in the city on the travel behaviour of non-workers. The model application suggests that the reduction in the usage of two-wheelers causes a reduction in the recreation participation by 21% and other trips by 23%. This reduction results in the increase of complex trips by 34%.

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