MODE SPLIT ANALYSIS FOR WORK TRIPS FOR HYDERABAD CITY

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A B S T R A C T

Hyderabad city is currently facing a variety of transportation problems due to inadequate road space associated with greater use of personalised modes. There is an urgent need for encouraging travel by public transport by appropriate strategy. The modal shares depend upon commuter sensitivity to level of service factors of different modes. Keeping in view the importance of work trips, mode split behaviour of Hyderabad commuters is carried out using ULOGIT model in the multimodal environment and a suitable transportation system is recommended.

1. INTRODUCTION

Hyderabad Metropolitan city, the capital of Andhra Pradesh is experiencing several transportation problems like congestion, delay accidents and environmental deterioration due to inadequate road widths, limited transportation network and high percentage of slow moving traffic. The 'Hyderabad Area Transportation Study (HATS) (1988)' revealed that about 20 lakh trips are being made on the city's network in all and the share of Public Transport (PT) is only 35 percent indicating that the majority of travel, is performed by personalised modes warranting wider roads. The recommendations of the study group on alternative system of urban transport (1987) indicated that the mode split expected for the city with its population levels is 50 percent. This warrants the reorientation of the policies for encouraging mass transit trips. However, since the travel by public transport and personalised modes depends upon the relative levels of service and the commuter behaviour of mode choice, it becomes necessary to understand the commuter behaviour of mode choice, sensitivity for level of service factors like time, cost etc. Keeping in view the importance of work trips, an attempt is made in this paper to estimate the mass transit patronage through mode choice behaviour of individual commuter.

2.PAST EXPERIENCES IN MODE CHOICE STUDIES

Many techniques have been summarised by HUTCHINSON (1974) and CHARI (1981) for mode choice modelling. While the earlier studies employed techniques like regression analysis, diversion curves etc., the latest literature revealed the adoption of Logit, Probit and discriminant analysis for mode choice study. The studies by GANEK (1976), LION (1975) indicated the wide use of logit models for mode split analysis of trips by purpose and further established the superiority of logit modelling over probit and discriminant analysis. SARNA (1985) discussed various issues concerning mode split aspects in mixed traffic situation. However, CHARI (1976) first proposed the disaggregated behavioural model for the mixed traffic and this aspect has been further probed by SINHA (1981), and GUPTA (1986). It has been brought out by these studies that multi logit models give sufficient accuracy in mode choice analysis under multimodal environment. With the help of the details given by TYE (1982), it has been established that disaggregate behavioural modelling of mode choice using Multinomial Logit (MNL) model yields good results and hence it has been adopt in the present study.

3.FORMULATION OF THE MODEL

3.1 Hypothesis of the model: The Multinomial Logit Model (ULOGIT Model) can be expressed as;

$$P(M) = Exp(-U(M)/SUM(Exp(\cdot U(I)), \quad (I = 1,...N) \ldots 1$$

Where;

P(M) = the probability that a traveller will choose mode 'M'.
U(M) = a (dis) utility function for mode 'M'
Exp = the Natural Logarithm base
U(I) = a (dis) utility function for a travel mode I
N = the entire set of travel modes identified in the study

The (dis) utility values are generally expressed as linear combination of impedence variables and socio-economic characteristics of the trip maker.

$$U(M) = f(t/m) + f(c/m) + f(S.E/m) \quad \ldots 2$$

Where;

f(t/m)= a function of time involved in making the trip by mode m
f(c/m)= a function of the cost of making the trip by mode m
f(S.E/m)= a function of socio-economic characteristics of the traveller

Each of the (dis)utility functions can be developed as a linear combination of relevant variables, each variable is adjusted (weighted) by a co-efficient as follows;

$$f(t/m) = (a0+a1*x1+a2*x2+....an*xn) \quad \ldots 3$$

Where;

f(t/m)= an impedance function for time for mode m
xi = the individual element within the impedence function (e.g. in-vehicle time, waiting time etc.)
ai = a coefficient to be derived as a part of model calibration

3.2 Selection of the independent variables: In equation 2 for disutility expression, three functions, namely time, cost and socio-economic conditions are to incorporated. The socio-economic condition is generally r by income, social status or indirectly by vehicle own tudy, people re stratified into Vehicle Owning cle People (NVP) to represent socio-economic chara tics of traveller exogeneously. Hence, travel time and travel cost ar he two variables considered to model the mode choice behaviour of trip maker.

3.3 Disutility funnctions : Various modes considered for this study are Own Vehicle (OV), Public Transport (PT), Intermediate Public Transport (IPT) and Walk. The disutility expression U for each mode are as follows;

U(OV) = Time co-efficient * OV time + Cost co-efficient * OV cost + OV bias

U(PT) = Time co-efficient * PT time + Cost co-efficient * PT cost + PT bias

U(IPT)= Time co-efficient * IPT time + Cost co-efficient*IPT cost + IPT bias

U(walk)= Time co-efficient * walk time

Time represents the door-to-door travel time and cost represents out of pocket expenditure.

4.MODEL CALIBRATION

The possible mode choices for VOP are his made, PT, IPT and walk while for NVP the choices are between PT,IPT and walk. Time and cost for each mode is estimated based on objective approach as suggested by Watson (1975). The ULOGIT program with in built subroutines is employed for model calibration.The output of the model contains coefficients alongwith the following diagnostic tests.

* t-test of co-efficients;
* Correlation between variables
* Log-likelihood value
* Pseudo R-square value;
* Observed Vs.Estimated totals for each alternative
* Table of Elastics

Tables I and II present the results of calibrated model for work purpose-VOP and work purpose-NVP.

Table I ULOGIT MODEL RESULTS FOR WORK PURPOSE-VOP

Coefficient Name	Final Value	Standar Error	t-ratio
1.Time coefficient	0.1263	0.0204	6.20
2.Cost coefficient	0.1061	0.1115	0.95
3.OV Bias	-1.1715	0.5657	-2.07
4.PT Bias	-0.4746	0.5615	-0.85
5.IPT Bias	2.7932	1.0854	2.57

The final value of log likelihood = -0.13342E03
Pseudo R-square = 0.6395293E00
Observed Vs.Estimated totals for each alternative:

Alt.	Obsd.	Estimate	Std.Residual	Corr.coeff.	Corr.ratio	No.of cells
OV	20.30	20.30	0.001	0.285	0.334	19
PT	57.00	57.00	0.000	0.284	0.354	21
IPT	3.00	3.00	-0.000	0.077	0.018	3
WALK	4.00	4.00	-0.002	0.265	0.120	4

TABLES OF ELASTICITY

NAME	OV	PT	IPT	WALK
1.OV Time	D-0.587	C 2.80	C 2.80	C 2.80
2.OV Cost	D-0.237E-01	C 0.113	C 0.113	C 0.113
3.PT TIME	C 0.721	D-3.590	C 0.721	C 0.721
4.PT COST	C 0.1773-01	D-0.881E-01	C 0.177E-01	C 0.177E-01
5.IPT TIME	C 0.216E-01	C 0.216E-01	D-3.59	C 0.216E-01
6.IPT COST	C 0.524E-02	C 0.524E-02	D-0.870	C 0.574E-02
7.WALK TIME	C 0.396E-02	C 0.396E-02	C 0.396E-02	D-9.99

Probabilities at average values of variables are;

0.827	0.167	0.006	0.000

TABLE II: ULOGIT MODEL RESULTS FOR --WORK PURPOSE-NVP

Coefficient Name	Final Value	Standar Error	t-ratio
1.Time coefficient	0.1154	0.0307	3.76
2.Cost coefficient	0.4233	0.2128	1.99
3.PT Bias	0.2537	0.4960	0.51
4.IPT Bias	1.0930	1.35	

The final value of log likelihood = -0.29562E02
Pseudo R-square = 0.7010119E00
Observed Vs.Estimated totals for each alternative:

Alt.	Obsd.	Estimate	Std.Residual	Corr.coeff.	Corr.ratio	No.of cells
PT	75.00	75.00	0.001	0.458	0.526	6
IPT	3.00	3.00	-0.000	0.081	0.067	3
WALK	12.00	12.00	-0.000	0.456	0.370	5

TABLES OF ELASTICITY

NAME	PT	IPT	WALK
1.PT TIME	D-0.604E-01	C 4.01	C 4.01
2.PT COST	D-0.674E-02	C-0.448	C 0.448
3.IPT TIME	C 0.337E-01	D-4.38	C 0.337E-01
4.IPT COST	C 0.287E-01	D-3.72	C 0.287E-01
5.WALK TIME	C 0.696E-01	C 0.696E-01	D-9.64

Probabilities at average values of variables are;

0.985	0.008	0.007

Note:1.D indicates Direct elasticity; 2. C indicates Cross elasticity
3.Elasticities are evaluated at average value

5 SENSITIVITY AND IMPACT ANALYSIS

5.1 Sensitivity analysis: Sensitivity analysis has been carried out to depict the powers of the model for micro responsiveness of the demand to changes in cost and time variables. A distance of 10 km. is chosen as datum and average time and costs per km. are obtained. Time and cost variables are varied by reducing to half to show the improvements and doubled to simulate the deteriorated condition of travel. By varying time and cost of a particular mode between the above limits, and keeping travel time and cost for all other modes, as constant, disutility values for each mode are calculated. By substituting these values in probability equation, probability of mode choices are calculated. The results are presented in Fig.1

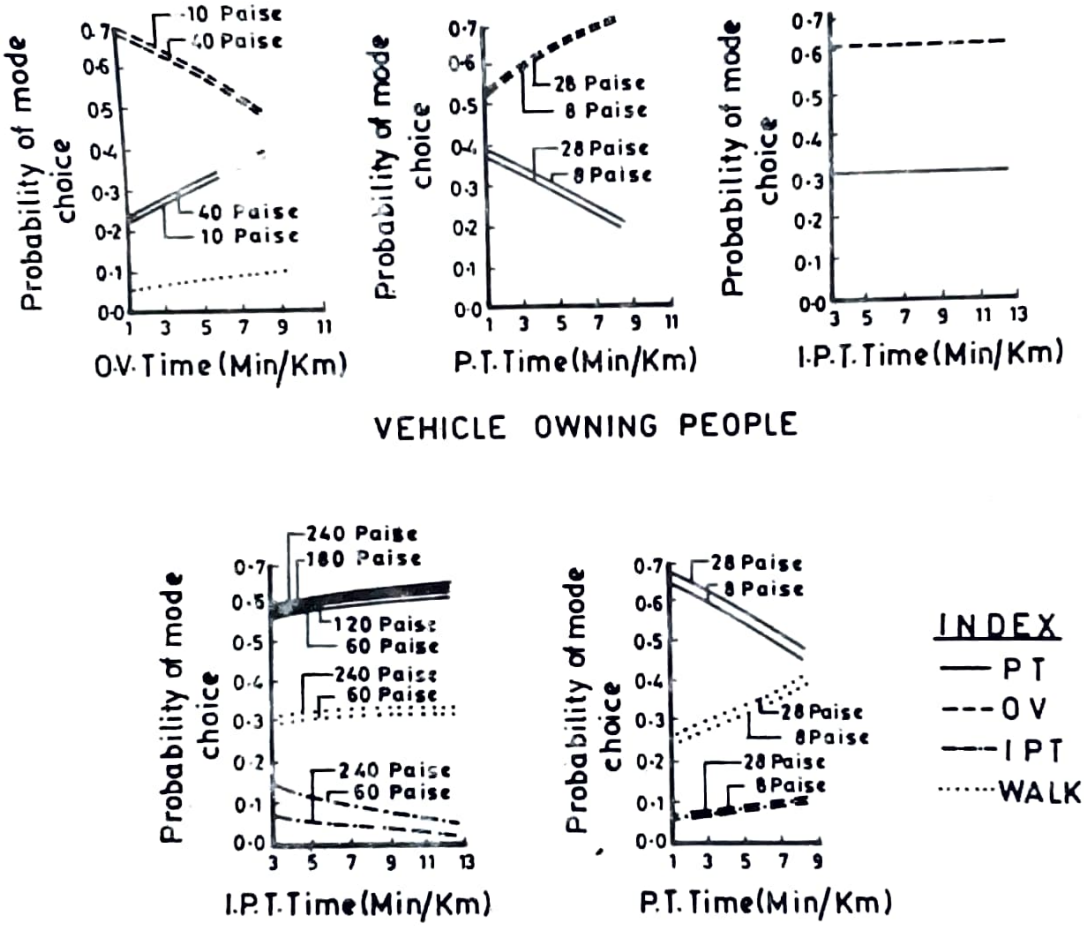

Fig.1 SENSITIVITY ANALYSIS CURVES FOR HOME BASED WORK TRIPS

Important findings from this analysis are;

* VOP are highly sensitive to OV and PT travel times. They prefer to go by their own mode for work purpose and their next choice is PT. VOP are declined to walk irrespective of the trip purpose. IPT time has little effect on probability of mode choices.
* It is observed that NVP are highly sensitive for PT time. PT and walk are the two modes mostly prefered by NVP when travel time of PT increases, they are shifting to walk mode. NVP are giving less preference to IPT and its travel time has negligible effect on probabilities of mode choices. Both categories of people, viz., VOP and NVP are less sensitive to cost of travel.

5.2 Impact analysis:The modal shares can be predicted by the help of the models developed. The only difficulty that may arise in predicting the future mode split is the estimation of parameters that decide the level of service of the transportation systems likely to be operated in future. However in the event of policy decision to encourage the travel by Mass Transit, an impact analysis can be carried out with various journey times and costs in predicting the probability of travel for PT. But as discussed in article 5.1, the mode choice behaviour of individual commuter is very much insensitive to cost of travel. On this basis, an impact analysis has been carried out for finding out the probability of trip making for work purpose for various assumed journey speeds in respect of PT. The results are presented in Table III.

TABLE III: PROBABILITY MATRIX FOR WORK PURPOSE

PT Journey Speed(kmph)	Probability of PT	OV	IPT	Assumptions: Mode	Journey Speed(Kmph)	Out of pocket expenditure
15	0.34	0.64	0.01	OV	25	0.35
20	0.43	0.56	-	PT	-	0.15
25	0.58	0.42	-	IPT	20	1.20
30	0.69	0.30	-	WALK	5	-
35	0.76	0.23	-			

As can be seen from the above analysis, it can be concluded that ;It is possible to shift the commuters from personalized mode to public transport by increasing the journey speeds and operational efficiency of these systems. However Complete dependence on Mass Transit by buses may not give the desired effect because of the limited capacity and operational problem on a common right of way. Hence it becomes essential to go for high speed, high frequency track guided systems at least on identified corridors.

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