# INTER-CITY MODE CHOICE ANALYSIS USING WLOGIT PACKAGE
## A CASE STUDY OF WARANGAL-VIJAYAWADA CORRIDOR

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A B S T R A C T

This study attempts to identify the variables influencing the mode choice behaviour of passengers in inter-city travel. A computer package, 'WLOGIT' is developed based on Multinomial Logit (MNL) formulation by bypassing the Independence of Irrelevant Alternative (IIA) property. The data, obtained through direct interviewing technique at selected towns along Warangal-Vijayawada Rail-Road corridor, is used in the analysis. Successive categories method is adopted in the quantification of attitudinal variables. From the analysis, it is found that time, cost, comfort and convenience variables are significant in predicting the mode choice behavior. However passengers are observed to be more sensitive to the variation in travel cost. Suggestions are made to get the desired mode share between Rail and Road passengers along the corridor.

## 1.0 INTRODUCTION

There are number of transport corridors in a region in which Bus, Train and other services compete each other. The share of travel by Train and Bus depends on the relative levels of service and on commuter behaviour. The level of service factors includes travel time, travel cost, comfort, convenience, reliability and noise disturbance of modes. The sensitivity of people for each of the above factors, differs based on the affortability and the travel situation. Proper identification of variables is pre-requisite to understand and to predict the mode choice behaviour of passengers. In this paper such analysis is carried out for Warangal-Vijayawada Rail-Road corridor by interviewing Rail and Bus passengers to assess their attitudes towards the modes and level of service offered by them. A mode choice package 'WLOGIT', by avoiding IIA property of the MNL, is developed. This model captures the behavioural aspects of the choice riderc. Drawing the information from the model, policy options are suggested to obtain the desirable mode split along the corridor to avoid underutilisation of systems.

## 2.0 METHODOLOGY

The widely used MNL model (Moshe E. Ben Akiva and Martin G.Richards, 1976, Chari, 1976; Chari and Khanna, 1978, Sinha, 1981, Virendra Kumar and Khanna, 1985, Prasad, 1988, and Ponnuswami et al 1992) assumes a property known as Independent from Irrelevant Alternative (IIA) implying that the ratio of probabilities of any two modes is independent of other modes. To bypass this restriction, Gaudry and Wills, (1979) proposed the 'DOGIT' model formulation through the introduction of Theta parameter, which enables to incorporate the disutilities of other modes as well. The ratio of probabilities of two alternatives 'i' and 'k' is

$$\frac{P_{in}}{P_{kn}} = \frac{e^{V_{in}} \cdot \theta_i \sum_j e^{V_{jn}}}{e^{V_{kn}} \cdot \theta_k \sum_j e^{V_{jn}}} \qquad (1)$$

where;

$P_{in}$ , $P_{kn}$ = Probabilities of choosing the ith and kth alternatives from choice set Jn

$V_{in}$ = Observed disutility function of alternative 'i' for an individual 'n'.
= $a_1$*Time + $a_2$*cost + $a_3$*comfort value + $a_4$*convenience value + $a_5$*Reliability value + $a_6$ * Noise disturbance value + $b_i$

$a_1$, $a_2$.. = disutility coefficients

$b_i$ = bias variable of 'i'

$\theta_i$ = Theta weight associated with ith alternative

Even in the two mode choice situation, the 'DOGIT's performance is

atleast equal to that of Logit or better than that.

Based on this approach, a computer programme 'WLOGIT' is written in Fortran language. The parameters ai and $\theta i$ in eq.1. are to be obtained by forming loglikelihood function and maximising it with reference to those parameters. Newton-Raphson algorithm is employed in the analysis. The 'WLOGIT' package gives the optimum values of disutility coefficients, Max. likelihood value, statistical summary of independent variables, their correlation matrix, direct and indirect elasticities of the modes for various variables. Statistical tests like Pseudo R-square, Standard error, T-ratio and percent correctly predicted are also incorporated in the 'WLOGIT'.

## 3.0 RAIL-ROAD PASSENGER STUDIES

Warangal-Vijayawada Rail-Road corridor is one of the major Rail-Road corridors in the state of Andhra Pradesh. It connects five important stations viz. Kazipet/Warangal, Mahabubabad, Khammam, Madhira and Vijayawada. It has a 220 km. of rail route and 270 km. road route . The railways operate several express and passenger trains on this rail corridor, where as the Andhra Pradesh State Road Transport Corporation Operates Super Delux, Semi-Luxury, Express and Ordinary services on the road.

The data required to predict the behavior of choice riders for inter-city travel along the corridor is obtained by direct interviewing technique. The format is prepared by framing questions related to socio-economic data of riders, level of service variables of Bus and Train modes and attitudinal variables like comfort, convenience, reliability and noise disturbance. Previous researchers (Recker and Golob, 1976) have suggested the psychometric scaling technique as suitable method to quantify the attitudinal variables and hence the same is used to quantify them. The attitudinal variables data was obtained on a 5-point psychological continuum in two stages.

Stage-1: Relative importance rating (Unimportant to extremely important) of all the variables.

Stage-2: Relative satisfaction ratings (very less to very high) of Train and Bus modes for each attitudinal variable.

It is assessed that the perceived importance of the attributes themselves are functions of characteristics of a group of travellers. It is also postulated that the relative rating of modes on the basis of some attribute is a function of the real difference that exists between the modes. Also the critical assumption made is that the distribution of response to stimulus is normal on the psychological continuum (Guilford, 1987).

The surveys were organised during the last week of January, 1993, one day at each town. They were administered in two shifts i.e. 7 A.M. to 1 P.M and 1 P.M. to 7 P.M. simultaneously at both Bus and Railway stations. In each shift, 12 trained enumerators (6 at Bus station and 6 at Railway station) were employed. The passengers who were waiting to board the Bus or Train, were randomly selected and interviewed. The purposewise split of the 762 passengers (both Train and Bus) interviewed is as follows;

| Work | Business | Social | Recreation | Others |
|---|---|---|---|---|
| 17% | 44% | 31% | 3% | 5% |

The attitudinal data obtained in first stage is quantified using the method of successive categories to find the scale values, which are given in Table 1.

Table-1: Scale Values of Variables

| Variable | Scale value, $I_a$ |
|---|---|
| Cost | 4.26 |
| Time | 10.59 |
| Comfort | 7.27 |
| Reliability | 6.55 |
| Convenience | 7.74 |
| Noise disturbance | 4.36 |

These scale values are considered as weightages for variables in disutility expression. The values of attitudinal variables are computed as follows;

$$Q_{ain} = I_a * S_{ain} \qquad (2)$$

where;

$Q_{ain}$ = The quantified value of the attitudinal variable 'a' for alternative 'i'for trip maker 'n'.

$I_a$ = The scale value of attitudinal variable 'a'.

$S_{ain}$ = The relative satisfactory level of attitudinal variable 'a' for alternative 'i' for trip maker 'n'.

The input data required for model calibration for each observation is mode chosen, Travel time (in hrs), Travel cost (in Rs.), attitudinal variables (as per eq.2) and their weightages. A data set consisting of all such observations in the required format, is prepared.

## 4.0 MODEL CALIBRATION

Initialising the Theta weights ($\theta_1$ and $\theta_2$) as zeros, the disutility coefficients are obtained through 'WLOGIT' package. The coefficients of 'reliability' and 'noise disturbance' are found to be statistically insignificant and hence, are dropped from the analysis. Revised scale values are obtained for the remaining variables. By incrementing Theta weights, values of disutility coefficients and Log likelihood value are obtained. This process is repeated until maximum likelihood value is obtained. Fig.1. depicts the variation of loglikelihood value with reference to the Theta weights.

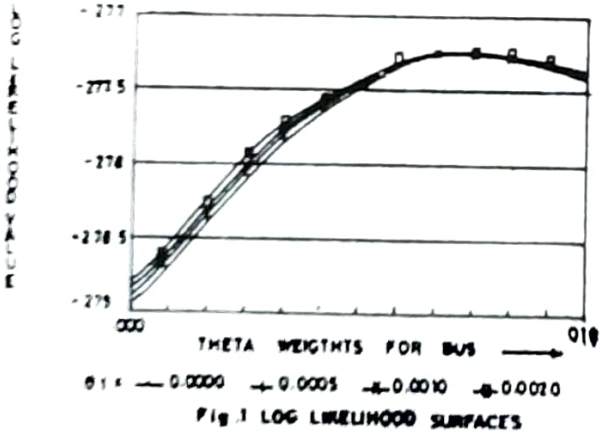


Fig 1 LOG LIKELIHOOD SURFACES

The optimum values of Theta weights and disutility coefficients at maximum loglikelihood are shown in Table 2. It is seen from the Table 2, that all the included variables are statistically significant. Time and cost coefficients are positive indicating that more the journey time, and journey cost, more will be the disutility for travel. Similarly, comfort and convenience coefficients are negative indicating that more the comfort and convenience offered by a mode, less will be the disutility or more will be the utility for travel. Negative Bus bias represents the omitted variable in disutility expression. The results shows that in addition to travel time and travel cost, comfort and convenience are also equally influencing the mode choice behavior of passengers in intercity travel.

Table 2: Optimal values of Disutility Coefficients

| Coefficient Name | Optimum value | T-ratio |
|---|---|---|
| Time coeff. | 0.08858 | 4.1 |
| Cost coeff. | 0.05201 | 6.4 |
| Comfort coeff. | -0.11786 | -7.1 |
| Convenience coef. | -0.05907 | -5.5 |
| Bus bias | -1.17115 | -5.5 |
| Theta weight for Train ($\theta_1$) | 0.004101 | |
| Theta weight for Bus ($\theta_2$) | 0.006751 | |
| Loglikelihood at zero coeffcients | | -542.4 |
| Loglikelihood at optimal values | | -277.2 |
| Rho-Index | | 48.9 |

## 5.0 POLICY SUGGESTIONS

The mode choice switching of passengers for a given change in travel time and travel costs of Bus and Train modes are carried out. By varying one variable at a time, while keeping all other variables fixed, probabilities of Bus and Train modes are computed. Fig.2 and Fig. 3 shows the probability curves for Bus and Train modes for a variety of time and cost combinations. The ratios in Figs.2 and 3 represents the ratio of proposed and present values of the variable.

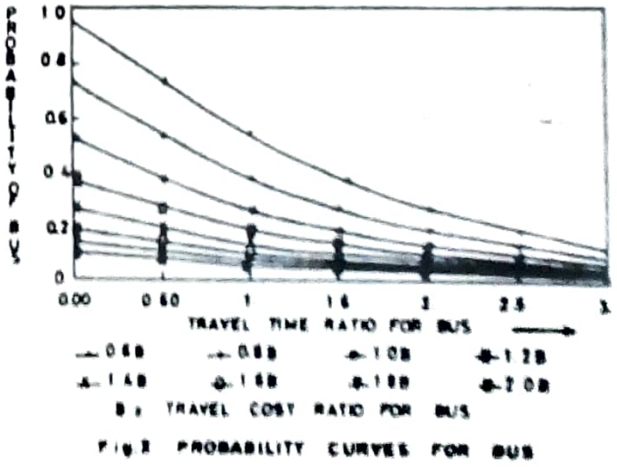


Fig 2 PROBABILITY CURVES FOR BUS

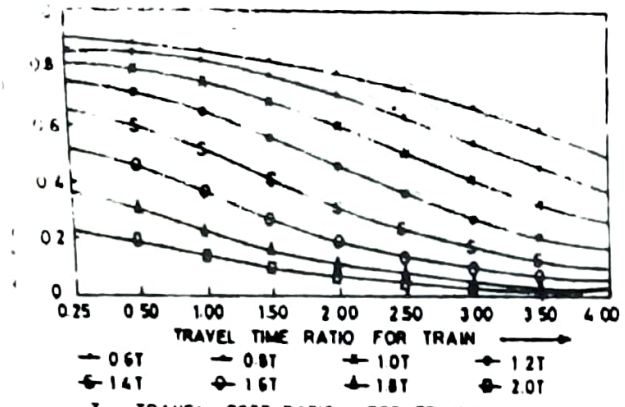


Fig.3 PROBABILITY CURVES FOR TRAIN

The passengers are observed to be ore sensitive to the cost of travel han time of travel. Hence, the study hows that ticket fare is the major actor in deciding the mode of travel tleast on regional level travel.

The present modal share between Bus nd Train along Warangal-Vijayawada orridor is observed to be 25% and 75% espectively. In order to encourage assengars to switch from Train to Bus t is therefore essential to reduce the ost of travel besides faster movements n Bus systems. In addition to the bove, comfort and convenience levels in us mode are to be improved further. able 3 shows the various suggestions to et the required Bus share, based on the nformation given in Fig.2.

If the present Bus fares are reduced y 6% or travel times by 15%, then the us share will reach 30%. Similarly to et 50 percent Bus share, the Bus fares re to be reduced by 34%.

able-3: Policy options to get required Bus share

| equired us share | Proposed policy |
|---|---|
| 25% | Present condition |
| 30% | 6% reduction in Bus fares, or 15% reduction in Bus travel time |
| 40% | 21% reduction in Bus fares, or 55% reduction in Bus travel times |
| 50% | 34% reduction in Bus fares |

In general, to enhance the comfort evels in Trains for long journey assengers and to minimise the nconvenience due to short trip ravellers, the Bus mode may be ncouraged for short distance journeys y adopting the above policies.

## 6.0 SUMMARY

This paper has presented mode choice analysis of inter city travel along Warangal-Vijayawada corridor. A computer package 'WLOGIT' was developed which bypasses the Independance from Irrelevant Alternative property of Multinomial Logit Model. From the analysis of the data collected on Warangal-Vijayawada corridor, the following conclusions are drawn:

* The coefficients of Reliability and Noise disturbance are statistically insignificant indicating their limited role in mode choice behavior at regional level

* The attitudinal variables comfort and convenience are also important as travel time and travel cost in deciding the mode of travel for inter city travel.

The mode choice behaviour of passengers for variations in travel time and travel cost is studied. The passengers are observed to be more sensitive for the variation in travel cost. From this analysis, it is observed that if the Bus fares are reduced by 34% then Bus and Train shares will be equal along the corridor.

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