Mode Choice Model for Intercity Travel — A Case Study

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1. INTRODUCTION

Intercity transportation planning is a vital link in the overall transportation planning process which directly affect between the urban transportation and regional transportation planning. The traditional method of estimating the travel demand function is to decompose it into a number of travel attributes associated with each of the descriptors of travel (origin, destination, mode and route etc.). Out of these "modal split" stage is very important as considerable amount of work has been done on trip generation and distribution and not much on this stage. The modal split stage involves establishing the modal share for the existing travel pattern, determining the response to causative factors and finally projecting the modal share for the future. There are number of routes along which both rail and road facilities are available. Without proper analysis and control of various variables responsible for modal split, there is every possibility of bus and train modes becoming competitive when they actually must be complementary. In this study it is proposed to do the mode split analysis using DOGIT model calibrated with the help of WLOGIT Computer package. Eluru-Vizag corridor in Andhra Pradesh is selected to test the validity of the computer package WLOGIT.

2. MODAL SHARE STUDIES IN INDIA - A REVIEW

The first on this was by Prof. Chari S.R., 1976, who used Logit for mode split analysis to Roorke and Ahmedabad data. Sarna, 1977, Sinha 1980, Gupta 1986 and Rao S.B.S., 1989 have done mode split analysis for Delhi, Patna, Warangal and Greater Bombay respectively. These are some of the mode split studies done for intra-city travel. Virendra Kumar and S.K. Khanna, 1984 for Saharanpur District, Thamizharsan V and Rengaraju V.R. 1986 applied regression models for inter-city travel demand modelling. Manjunatha K.N., Harikishan Reddy have applied MNL and DOGIT for Warangal-Hyderabad and Vijayawada-Warangal corridors respectively.

Disaggregate models have been selected for the present study to estimate the modal share. The Dogit model is selected because it avoids or dodges the researchers dilemma of choosing a priority between a format which commits to Independent from Irrelevant Alternatives (IIA) restrictions and one which excludes them whence its name (Gaudry and Dagenias, 1978). The model can be expressed as

$$Pin = \frac{e^{V_{in}} + \theta_i \sum e^{V_{jn}}}{(1+ \theta_j) \sum e^{V_{jn}}}$$

Where,

P_{in} =Probability of choosing `ith' alternative in `N' alternatives
θ_i = Mode captivity parameter
V_{jn} = Strict Utility or deterministic utility

A computer package Wlogit is used with the above mentioned model for which the input variables are the travel time, travel cost and the attitudinal variable (Comfort, convenience, reliability and dust and noise).

Data Collection

Eluru-Vizag Corridor has got four major stations. Eluru, Rajahmundry, Kakinada and Vizag. Here the intercity bus operation is taken over by the Andhra Pradesh State Road Transport Corporation and the train facility by South Central Railways. The bus route corridor has a length of 307 kms. without touching Kakinada and 340 kms. via Kakinada and for the train route, it is 292 Kms. Regarding bus service, APSRTC, is operating ordinary express, semi-luxury and luxury services on these routes. The surveys were conducted at the above mentioned stations using a specially designed questionnaire.

Survey Questionnaire

The survey questionnaire for bus and rail passenger mode share analysis consists of three parts. The first segment of the questionnaire consists of set of questions to collect the socio - economic characteristics of the passengers. The second part consists of the questions related to travel data like trip origin, destination, ingress and egress details. The third part of the questionnaire is divided in to two parts. The first category of the questions collect the information about the attitudes of the people to travel cost, time comfort reliability, convenience and dust and noise disturbances. The weightages to these attitudes are given on a rating scale. The second category of the questions collect the information regarding the relative satisfactory levels of the above mentioned attributes for bus and train.

Sample Size

The total number of samples collected are 838. Out of the total number of passengers interviewed, 295, and 436 are for bus and train modes respectively. The total number of passengers travelled in one week is collected and the average of the one week data is taken as the representative day sample. This data is collected from Statistical returns (S.R.s)for bus and booking charts for train. Based on the ratio of the total number of samples collected and total number of passengers travelled, the sample size is determined and presented in Table 1.

Table 1 : Sample Size

Origin - Destination	Total Travelled by Train	Train Samples taken	Total travelled by bus	Sample taken	Sample Size (%age)
Eluru - Rajahmundry	81	24	166	49	29.5
Eluru - Kakinada	21	8	18	7	38.0
Eluru - Vizag	148	22	24	4	14.8
Rajahmundry - Eluru	109	18	111	18	16.5
Rajahmundry - Kakinada	66	8	2788	125	4.5
Rajahmundry - Vizag	554	77	142	20	13.9
Kakinada - Eluru	94	8	8	2	8.2
Kakinada - Rajahmundry	98	5	2892	139	4.8
Kakinada - Vizag	484	48	488	48	9.9
Vizag - Eluru	132	8	25	2	6.1
Vizag - Rajahmundry	504	42	81	7	8.33
Vizag - Kakinada	436	24	420	23	5.50

Apart from the primary data collected from the passengers, The secondary data regarding route distance, travel time and travel cost by bus and train. The distance matrix between the cities is presented in Table 2.

Table 2 : Bus Route distances

City	Eluru	Rajahmundry	Kakinada	Vizag
Eluru	-	95	169	307 / 340*
Rajahmundry	-	-	75 / 70+	212
Kakinada	-	-	-	173

Note: * The rare two parallel routes from Rajahmundry to Vizag , one touching Kakinada and the other without touching Kakinada.

+ From Rajahmundry, there are two parallel routes to reach Kakinada, One is Via Rajanagaram and the second one is via Mandapet

Analysis

Fig. 1 to Fig 14 indicates the socio - economic profile of the passengers for bus and train modes respectively. Some of the findings from this study are :

1. Nearly 80 pay percent of the passengers who are travelling in the train are workers who belongs to Middle Income Group and High Income Groups who can pay the price in terms of money but they require comfort and less travel time

2. Purpose wise analysis of train passengers indicate that majority of the passengers are travelling social purpose (43%) for whom comfort is of prime importance while choosing the mode.

3. Majority of the travellers travelling in bus are for work and business purposes. This category of passengers will give preference to the travel time, convenience and reliability of the mode.

4. Classification based on the origin in bus data analysis explains that the number of passengers boarding from Vizag is less compared to the all other cities in the study area. This indicates the passenger s preference towards the travel time.

5. The income wise analysis of the bus passengers shows that this mode is carrying majority of the HIG and LIG people.

6. Age wise analysis describes that the passengers between 19 -34 years are travelling in the bus especially for work and business purposes, who are satisfied with less comfort but more priority to the convenience and reliability.

7. From the data collected along Eluru-Vizag corridor, it is found that highly educated are preferring train to bus. The difference in travel time and cost for both bus and rail passengers are due to the number of rural passengers boarding bus are more than that for train.

8. The average waiting time for train travellers at the railway stations is 23 min. Compared to the average waiting time of 14 min. for bus passengers at bus stations. This clearly indicates the reliability of the bus mode along this corridor.

Quantification of Attitudinal Data

The attitudinal data obtained is quantified through method of successive categories, a psychometric scaling technique and the findings are listed in Table 3. The attitudinal variable quantified in this study is made up of four attributes viz. Comfort, convenience, reliability and noise disturbance. The passengers are requested to give their relative importance and satisfactory levels of each attribute on a five point rating scale which varies from extremely not importance to extremely important. In this method, it is assumed that, categories are in correct rank order and that their boundary lines are stable except for sampling errors. The critical assumption made is that the distribution of response to stimulus is normal on the psychological continuum (Guilford, 1987). It is assessed that the perceived importance of the attributes themselves are functions of characteristics of a group of travellers.

Table 3 : Scale values for the Attitudinal Data

Attributes	Scale Value
Travel Cost	5.0867
Travel Time	10.5226
Comfort	8.0484
Convenience	9.0060
Reliability	8.6596
Dust and Noise	6.0614

The Table 3 indicates that the passengers are giving the first preference to the travel time rather than giving it to the travel cost. The people in this corridor are afford to pay the money, if the bus / train reaches in time, with good comfort, reliability and least disturbances.

Sensitivity analysis

From the analysis carried out it is found that the passengers are valuing travel 1.25 times the travel cost. In order to shift the passengers from train mode, there is an immediate necessity to reduce the travel time per bus or increase the comfort, convenience, reliability and dust and noise by bus. The following table (Table 4) can be made use to arrive at a policy which gives saturation flows for both bus and train modes. Fig. 15 to Fig.18 gives the modal shares with the changes in travel time and costs which are helpful in policy decisions.

Table 4 : Modal shift with the changes in travel time and travel cost

Train Time	Train Cost	Bus Probability	Bus Probability
1.0	1.0	0.47	0.53
1.0	0.9	0.48	0.52
0.72	1.0	0.50	0.50
0.80	0.85	0.67	0.33

The modal share of the observed data along this corridor is 51% and 49% for the train and bus mode respectively, where as the computed modal share through WLOGIT are 53% and 47% with an error of 2% which is considered to be negligible. Hence the computer package Wlogit is practically suitable in estimating the modal share with high accuracy.

CLASSIFICATION BASED ON GENDER
TRAIN DATA ANALYSIS

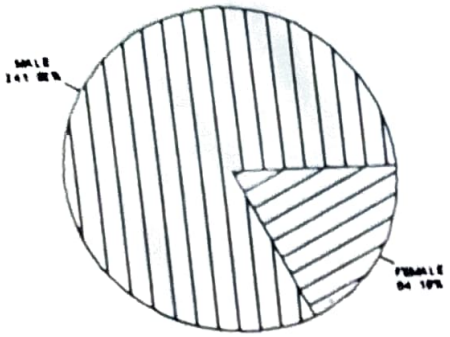

Fig 1

CLASSIFICATION BASED ON MARITAL STATUS
TRAIN DATA ANALYSIS

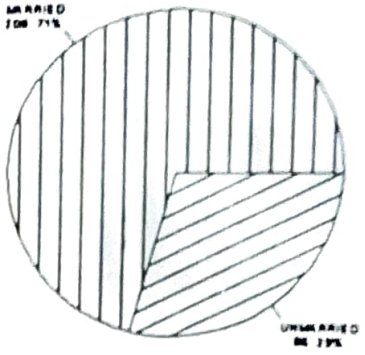

Fig 3

CLASSIFICATION BASED ON AGE
TRAIN DATA ANALYSIS

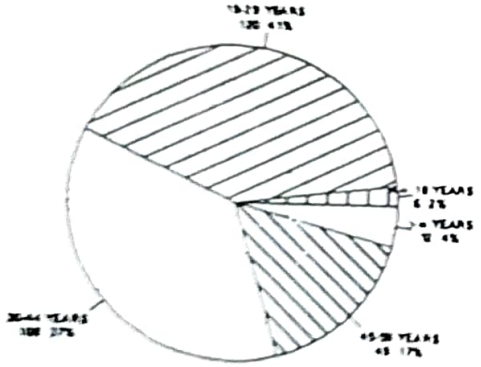

Fig 2

CLASSIFICATION BASED ON GENDER
TRAIN DATA ANALYSIS

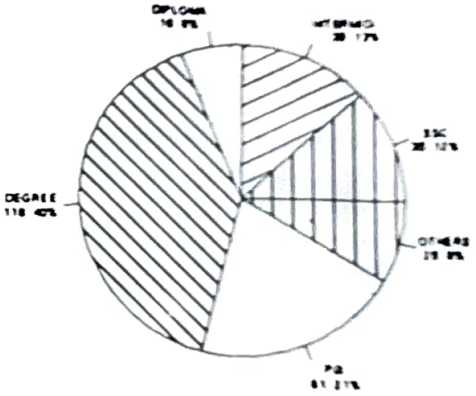

Fig 4

CLASSIFICATION BASED ON OCCUPATION
TRAIN DATA ANALYSIS

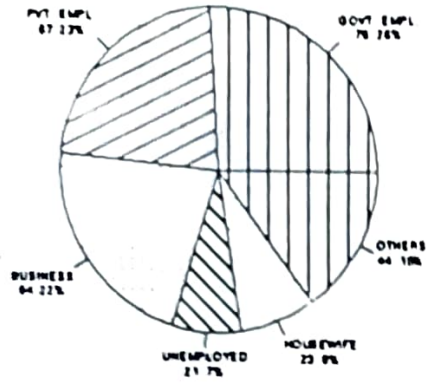

Fig 5

CLASSIFICATION BASED ON INCOME
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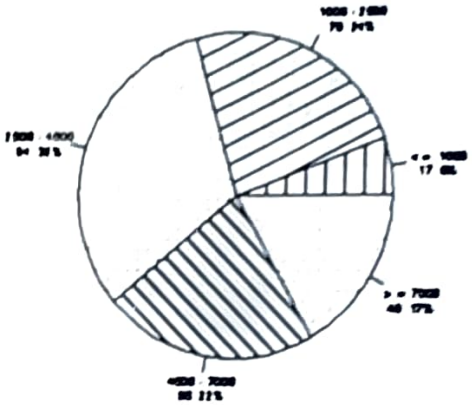


Fig 7

CLASSIFICATION BASED ON TRAVEL PURPOSE
TRAIN DATA ANALYSIS

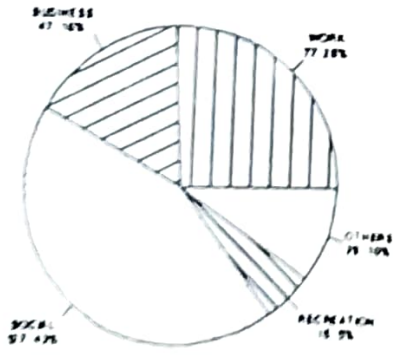


Fig 6

CLASSIFICATION BASED ON ORIGIN
TRAIN DATA ANALYSIS

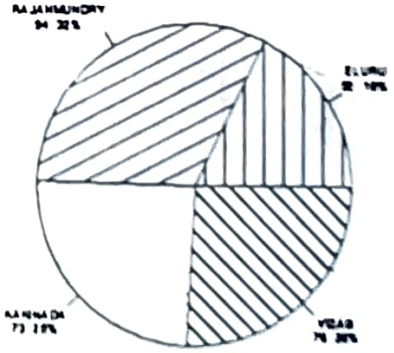


Fig 8

CLASSIFICATION BASED ON GENDER
BUS DATA ANALYSIS

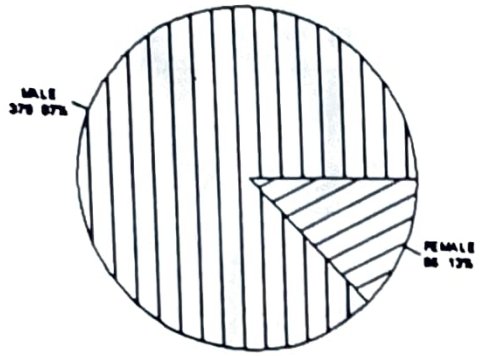


Fig 9

CLASSIFICATION BASED ON AGE
BUS DATA ANALYSIS

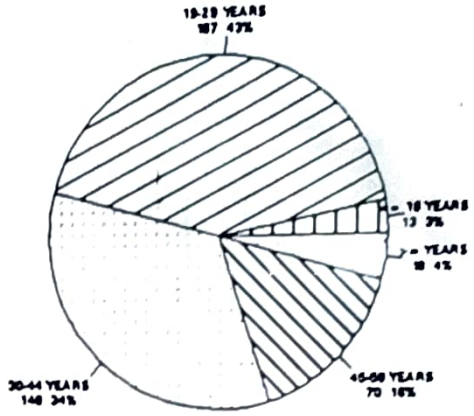


Fig 11

CLASSIFICATION BASED ON MARITAL STATUS
BUS DATA ANALYSIS

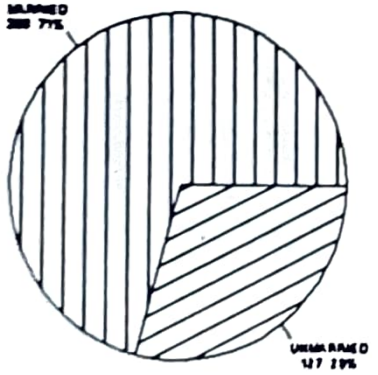


Fig 10

CLASSIFICATION BASED ON EDUCATION
BUS DATA ANALYSIS

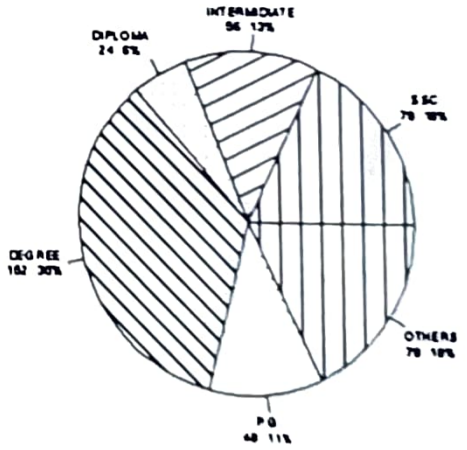


Fig 12

CLASSIFICATION BASED ON OCCUPATION
BUS DATA ANALYSIS

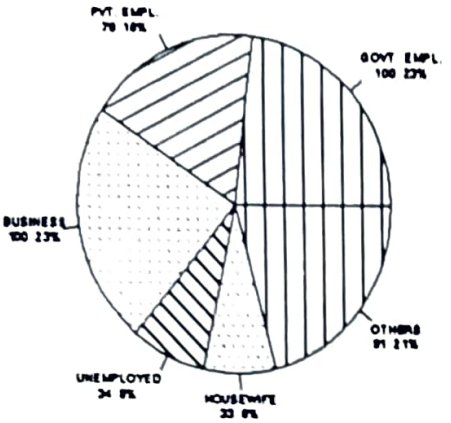


Fig 13

CLASSIFICATION BASED ON TRAVEL PURPOSE
BUS DATA ANALYSIS

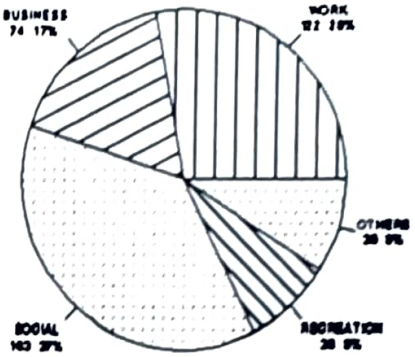


Fig 15

CLASSIFICATION BASED ON INCOME
BUS DATA ANALYSIS

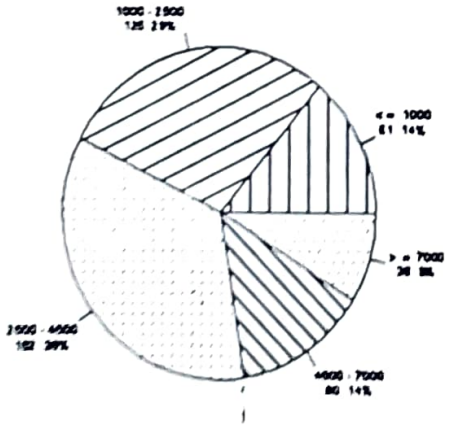


Fig 14

CLASSIFICATION BASED ON ORIGIN
BUS DATA ANALYSIS

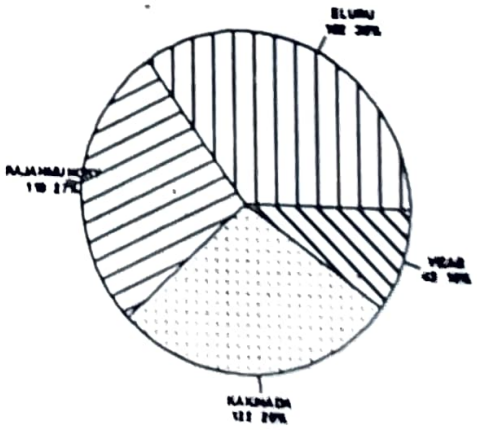


Fig 16

MODAL SPLIT PROBABILITY OF TRAIN

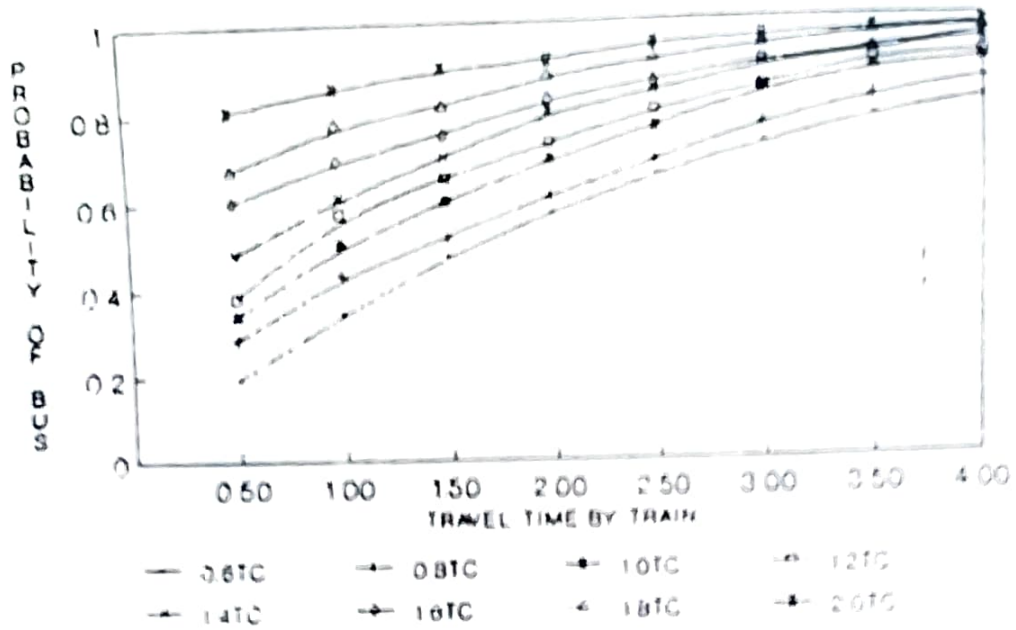
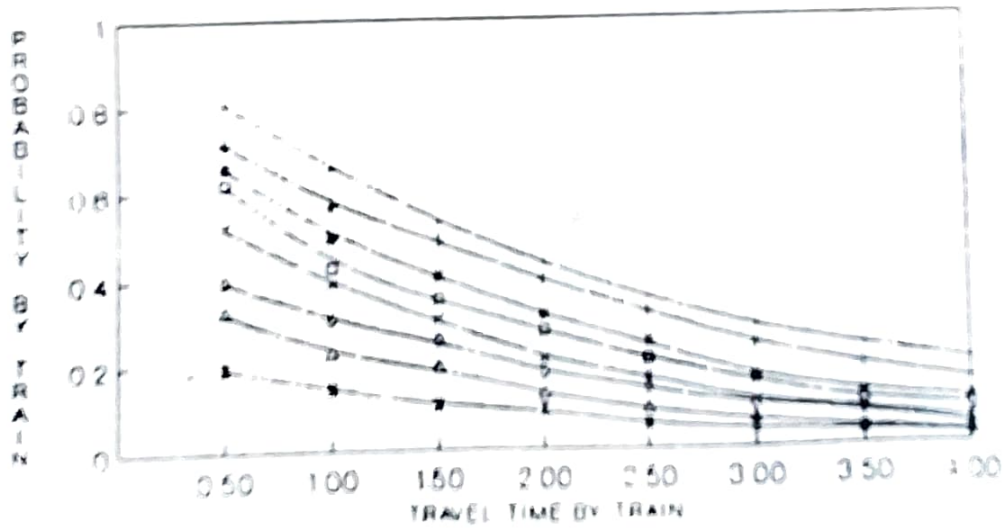


FIG 17.000 LOGIT MODEL PROBABILITIES

MODAL SPLIT PROBABILITY OF TRAIN



MODAL SPLIT PROBABILITY OF BUS

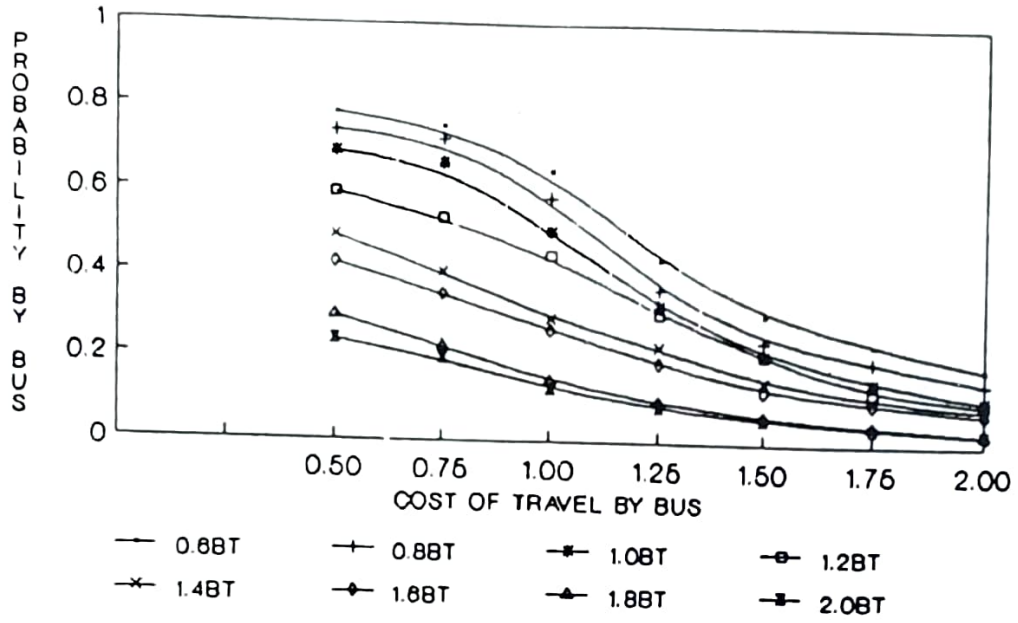


Fig 19 DOGIT MODEL PROBABILITIES

MODAL SPLIT PROBABILITY OF BUS

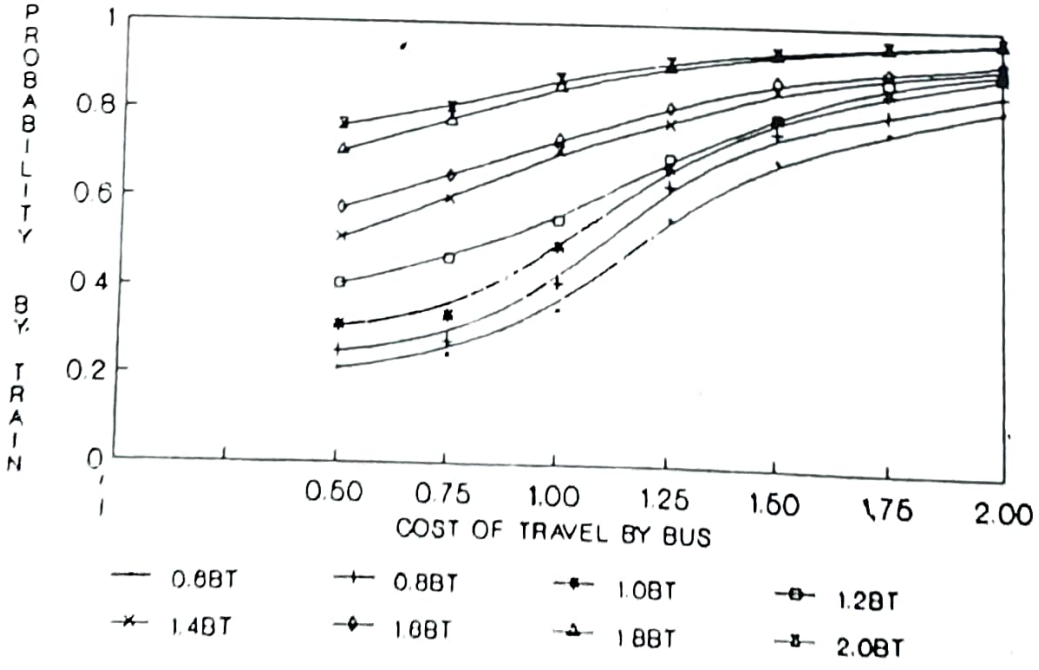


Fig 20 DOGIT MODEL PROBABILITIES

Summary

The paper has examined "Intercity Mode Split analysis for rail-road passenger modelling" along Eluru-Vizag Corridor for analysis purpose, WLOGIT package is used which is least affected from IIA property. The passengers are interviewed by direct interview technique and found the share is almost equally distributed among both the modes. The attitudinal data is quantified through the psychometric sealing technique named *Method of Successive Categories*.

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