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Willingness to Shift from Car to Bicycle- A Case Study of Calicut City

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***Abstract*—In Kerala, commonly used non-motorised modes of transportation are walking and cycling. In the past, most of the people used cycling and walking for all purposes. Due to the advent of motorised modes of transport, there is a considerable decrease in theshare of bicycle users. The present study aims to find out the percent of shift of people from car to bicycle if segregated cycle track is available on roads. Stated preference survey was used to assses the willingness to shift from car to Cycle. The parameters considered for the willingness to shift study were age, trip purposes and travel distance. Logit model was used to determine out the probability of shift from car to bicycle. From the survey it was concluded that 45% of the people, whose age is less than 25 years and are of essential trip makers, arewilling to use bicycle if segregated cycle trackis available.**

***Keywords*—Pedestrian,Cyclists, Stated preference survey, Logit model.**

I. INTRODUCTION

In the past bicycle was used by people as a popular mode of transport. Most of the people used bicycles for various purposes like going to school, tuition centres, work places, delivering goods or services etc. But over the years, the share of bicycle has declined due to the arrival of faster modes of transport. Also absence of infrastructure for cycling has discouraged people from using bicycle. Another common mode of non-motorized transport is walking. This paper assesses the willingness of car passengers to shift to bicycle in the city of Calicut.

Calicut is a major city on the northern half of Kerala situated right on the Arabian Sea coast. Calicut is the third largest city in Kerala after Kochi and Thiruvananthapuram with a population of 4,31,560 (as per 2011 census).It is observed that even if people have cycle, they use it only during off peak hour of traffic. Cycling infrastructure is completely absent in the Calicut city. By providing safe infrastructure for Cyclists–segregated cycle track will lead to safe and convenient travel for cyclists.

II. SCOPE AND OBJECTIVES OF STUDY

The scope of the study is confined to the corporation area of Calicut city. Stated Preference and Revealed Choice surveys were conducted to collect the required information to evaluate the willingness to shiftfrom car to bicycle in the Calicut city region.

Objectives of the study included,

- To assess the present modeshare in the study area.
- To determine the probable shift to bicycle if proper infrastructure is providedin the city.

III. LITERATURE REVIEW

A modal shift occurs when one mode attains a comparative advantage in travel over another. The comparative advantagemay occur due to various factors such as travel costs, travel time, travel distance, accessibility, flexibility, or reliability. Depending on the profile of passengers traveling and their circumstances, the relative importance of each of these factors mayvary.

Hensher (1993) studied the stated preference analysis of travel choices. Stated preference (SP) methods are widely used in travel behaviour research, to identify behavioural responses to choice situations which are not revealed in the market, and where the attribute levels offered by existing choices are modified to such an extent that the reliability of revealed preference models as predictors of response. The main themes addressed include a comparative assessment of choice models and preference models, the importance of scaling when pooling different types of data, especially the appeal of SP data as an enriching strategy in the context of revealed preference models, hierarchical designs when the number of attributes make single experiments too complex for the respondent, and ways of accommodating dynamics (i.e. serial correlation and state dependence) in SP modelling.

Alvinsyah*et al.* (2005) developed a binomial Logit model based on stated preference survey and response of the travellers in using the proposed Jakarta bus-way system. The main variables considered to develop utility functions were travel time and travel cost. On the basis of characteristics of the model, the perception of people and their probability of selecting the proposed system are predicted. The result of this study shows a wide range of people perception and their probability towards better service.

Rakesh Kumar *et.al* (2014) a case study of Impact of proposed Modal shift from Private users to Bus Rapid Transit System was conducted in India. In this study, commuter mode choice analysis is performed that examines behavioural responses to the proposed Bus Rapid Transit System with estimation of the probable shift from private mode to public mode. House hold survey was conducted for data analysis in this both revealed preference survey and stated preference survey were used. A multi modal Logit model was used for the analysis.

IV. RESEARCH METHODOLOGY

Methodology adopted for the study is described in this section. These include data collection, data analysis and development of Logit model. Questionnaire survey method was used to collect required data for model development. Socio economic data from Revealed Preference (RP) survey and choice of mode from Stated Preference (SP) survey were usedfor mode shift analysis. Response of people, i.e., the willingness to shift from current mode was modelled as a function of independent variables including socio economic characteristics and trip characteristics. Binary Logitmodel was used to estimate the shift from passenger car to bicycle.

A. Collection of data

The survey was carried out at various shopping centres, public offices, parks and recreation centres in Calicut city region.Socio economic characteristics of respondents were also collected. Stated preference (SP) questions were asked to the respondents to know the attitude towards the proposed cycling infrastructure. Questions were asked to the respondents whether they are willing to use bicycle if having segregated cycle track. Overall 2486 responses were collected from various locations in Calicut city.Distance travelled by respondents was found to vary from 0.5 km to 20 km. It was observed that trip purpose of 1467 respondents was essential and remaining respondent's trip purpose was non-essential.Among the total respondents, the sample number of car users surveyed was 448.

B. Modal share

Present mode share characteristics of the respondents in Calicut city was evaluated from Revealed Preference Survey. It was observed that 18 percent of the respondents usepassenger cars for their travel and small percentage of them are using auto cycle and walk.

The mode share of the Calicut city is given in Figure1.

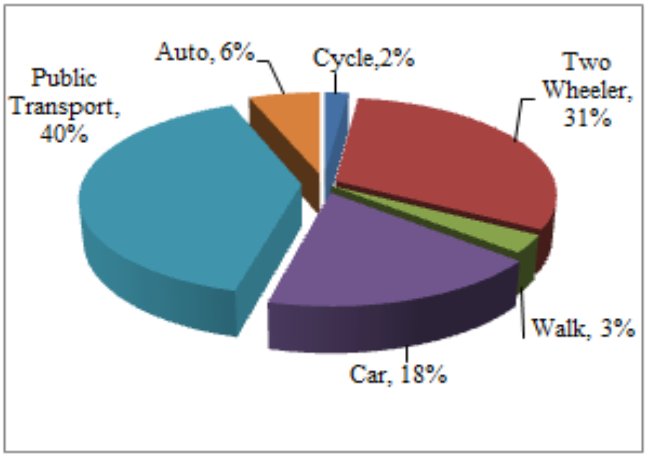

Fig.1. Mode share of the Calicut city

V. DATA ANALYSIS AND MODEL DEVELOPMENT

Data collected from questionnaire survey was analysed. Binary logit model was developed for the passenger car to predict the modal shift towards the proposed facility. The study found that age, trip purpose and travel distance were the significant factors that affect mode choice. The reason for unwillingness was also analysed.

A. Model formulation

The model formulated is based on Utility theory (U), and utility maximization. The parameters such as savings of travel cost and health are taken into consideration for assessing probable shift. Age, trip purpose and travel distance were selected as the independent variables and willingness or non- willingness to choose non - motorised transport modes were taken as dependent variable in modeling.

The utility is mathematically expressed as a linear relationship between dependant variable and independent variables. The utility U_{iq} of an alternative can be represented by two components:

- V_{iq} is a measurable part which is a function of the measurable attributes X;
- ε_{jq} is the random part or observational errors made by the modeller.

Thus the $$U_{iq}= V_{iq} +\varepsilon_{iq} \quad (1)$$

According to the theory, a person will choose upcoming facility ifits utility is more than that of the existing facility. The utility of NMT is more than other motorised modes of transport while considering the quantitative factors like travel cost and qualitative factors like health benefits. The travel cost of NMT is zero or negligible when comparing with other modes of transport. So the utility difference is $U_{difference} \geq 0$.

i.e. $$V_{diff}= V_{Cycle}-V_{Car} \quad (2)$$

$\varepsilon_{diff}=\varepsilon_{NMT}-\varepsilon_{Current\ Using\ Mode}$, representing unobserved factors affecting choice. Therefore, the probability of shift can be obtained as:

$$P_{shift}= Pr(U_{diff} \geq 0) = Pr(V_{diff} + \varepsilon_{diff} \geq 0)$$

$$= \frac{e^{Vdiff}}{1+e^{Vdiff}} \geq 0 \qquad (3)$$

The deterministic term V_{diff} is assumed to be given by a linear-in-parameters specification. Accordingly,

$$V_{diff}=A_0 + A_1X_1 + \cdots + A_nX_n \qquad (4)$$

Therefore, the probability of shift can be given as

$$P_{shift} = \frac{e^{Vdiff}}{1+e^{Vdiff}} = \frac{e^{A0 + A1X1 + \cdots + AnXn}}{1+e^{A0 + A1X1 + \cdots + AnXn}} (5)$$

whereP_{shift} is the probability of shift from current mode to proposed mode;; A_0, A_1, $A_2\cdots$ are the model parameters to be estimated; X_1, $X_2\cdots$ are variables considered for analysing modal shift.

B. Mode shift models for car to bicycle

For analysing mode shift model the variables considered are age, trip purpose, travel distance. Age group is subdivided into two - the age less than or equals to 25 yearsand above 25 years. The trip purpose of the respondents were classified as essentialand non-essential trip makers. Trip length travelled by car passengers was grouped as less than 2km and more than 2km. The dependent variable is the response of people towards proposed facility. Binary Logit models were developed usingStatistical Package for the Social Sciences (SPSS).

Model calibration

Calibration involves estimating the values of various constants and parameters in the model structure. Estimating model coefficients and constants is usually done by solving the model equations by using observed values of dependant variable and independent variable. The estimation process is a trial and error effort that involves the parameter values which have the greatest probability or maximum likelihood of being accurate within acceptable tolerance of error.

For the purpose of model calibration, from each mode, a set of data points (80% of the total) was used, while setting aside the rest of the observations (20%) for the purpose of validation. SPSS was used for model calibration analysis. The goodness of fit for the calibrated model can be assessed by likelihood ratio index (ρ^2), which is given as,

$$\rho^2 = \frac{LL(P)-LL(0)}{LL(0)}$$

Where LL (P) is the log-likelihood of the estimated model and LL (0) is the log-likelihood when the coefficients are assumed to be 0. The model calibration results of shift from car users to cycle are shown in Table I. The value of the t-statistic for different variables, when compared with the corresponding table value and p-values are below 0.05, indicate that all the paramers are significant at 5% level.

TABLE I. CALIBRATION RESULTS OF SHIFT FROM CAR USERS TO BICYCLE

Mode	Variables	B	t-statistics
Car	Constant	-4.39	-8.27
	Age 1	1.02	2.27
	Trip –E	1.40	2.91
	Travel Distance 1	1.77	3.95

Model validation

For the model validation, the holdout data set, with 20% data points, was used.Then calculated log likelihood value, initially calibrated using the 80% data points was applied to the hold out sample with 20% data points.

TABLE II. VALIDATION RESULTS OF SHIFT FROM CAR TO BICYCLE

Calibration	Initial LL	179.33
	Final LL	145.67
	Estimated ρ2	0.23
Validation	Initial LL	83.79
	Final LL	68.52
	Estimated ρ2	0.23
Calculated LL		69.38
Calculated ρ2 value		0.24

Then, the two values (estimated and calculated) of LL were compared for determining their closeness. The rho square values of estimated and calculated holds the same and arealso within the limits. The rho square value should be 0.20 to 0.40 (Tischer et.al 1979). So the modelfit is good.The details are shown in theTable II.

C. Probability of shift from car to cycle

The probabilities of shift from car to cycleis computed from the mode shift models considering the parameters and shown below in Table III.

TABLE III. PROBABILITY OF SHIFT FROM CAR USERS TO CYCLE

Parameters considered `			Probability of mode shift fromCar
Travel Distance	Trip Purpose	Age (years)	
≤ 2km	Essential	≤ 25	0.45
		> 25	0.28
	Non-Essential	≤ 25	0.17
		> 25	0.07
> 2km	Essential	≤ 25	0.12
		> 25	0.05
	Non-Essential	≤ 25	0.03
		> 25	0.01

D. Reason for not using Cycle

From the questionnaire survey, the reason for not using cycleamong car passengers is evaluated. The reason for not willing is analyzed based on five parameters
These are,

- Not interested
- Due to health reason
- Comfortable with vehicle use
- Status symbol
- Allergic to dust

The attitude of people towards cycling is an important factor contributing to their unwillingness. Among unwillingness, 43% of them shownno interest towardscycling and32%are comfortable with car use.Most of respondents like the facility but can't use the facility because of his/her age, health problems etc.The reason for not using NMT is shown in below Figure 2.

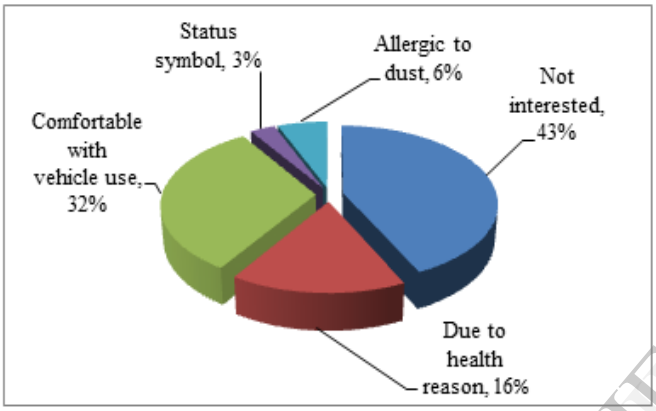

Fig. 2. Reason for not using cycle among car users

VII. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were drawn from the present study.

- The modal share of the city was assessed and observed that 18% of the people were using car for their trip purposes and only 2% of them were using cycle.
- From the study, a set of factors that explained the variation in shift of motorised mode users to non-motorised mode has been identified.The identified factors were: gender, travel distance and trip purpose.
- The quantitative factors like travel cost are negligible; qualitative factors like health benefits were considered by the people to shift from the car tocycle.
- The probability of shift of car users to cycle showed value0.45when the travel distance is less than 2km and 0.12 in case of travel distance is more than 1km.
- The probability of shift to cycle was observed more in case of essential short trip users than essential long trip users.
- From the analysis it was found that most of the short trip travellers and youth are willing to use cycle, if having segregated cycle track in the Calicut city.
- It is desirable that cycle tracks should be provided on both sides of a road and should be separated from the main carriageway by a verge or berm of as much width as possible, the minimum width of verge being one meter. Under exceptional circumstances, eg., in towns where the width of the road land is in adequate, the width of the verge may be reduced to 50 cm. (IRC: 11-1962).
- The minimum width of pavement for a cycle track should not be less than 2 lanes, i.e., 2 meters (IRC: 11-1962).
- To attract cyclists to use cycle track, it is essential that cycle track should be constructed and maintained with care and should have riding qualities and lighting standard equal to or better than those of the main carriage way
(IRC: 11-1962).

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