ROUTE CHOICE MODELLING USING ADAPTIVE NEURAL–FUZZY INTERFACE SYSTEM AND LOGISTIC REGRESSION METHOD

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Abstract—Route Choice is a most important stage in Transportation Planning process. It is difficult to identify behaviour of driver at a particular Heterogeneous traffic condition like India. The traveller depends on Parameters like travel time, delay time, traffic safety, travel cost, traffic congestion etc. The Parameters are correlated to each other, therefore it is very difficult to identify behavioural characteristic of traveller. In this paper the development of route choice model using Adaptive Neuro-fuzzy Interface System (ANFIS) and Logistic Regression Method (LRM) is quite successful in predicting the route choice with reasonable accuracy. ANFIS is an addition of Fuzzy and Neuro interface that predict behavioural characteristic of traveller and LRM also predict binomial situation on roads like traffic safety, travel time, traffic congestion etc. This paper enhances accuracy of Route Choices with the help of those methods and it also helps to access predictable routes for driver with respect to time at peak hour period thus reducing traffic congestion.

Keywords—Route Choice Model, Parameters, Adaptive Neuro-fuzzy Interface System, Logistic Regression Method

I. INTRODUCTION

Today before going to destination, we thinking about traffic condition. So, at the time of peak hour route choice [2] is very difficult to access the routes of a particularly heterogeneous traffic condition like in India. Route choice problem involves the selection of a path between a given origin and destination, when faced with a road network consisting of many nodes, links, origins and destinations.

Route choice behaviour of drivers has a great influence on traffic flow patterns. It is fundamental to the traffic assignment step in travel forecasting models and to the traffic simulation models.

There are several difficulties in route choice behaviour modelling [6,7]. The perception of the traveller may vary. The acceptable performance level varies with traveller. The route attributes considered and the perceived values associated with these attributes also vary. Hence the choice of the best route is not the same for all travellers. The route choice models based on random utility theory has the limitation that it cannot model the vagueness in driver behaviour. Hence they cannot predict route choice accurately.

II. STUDY STRETCH

The study stretch connecting to commercial sector and it also connection to International Airport and Railway Station. The study stretch having eight major traffic
intersections (Power House Chowk, Raj Bhaban Chowk, A.G Square, Rajmahal Square, Master Canteen Chowk, PMG Square, Rabindra Mandap Square, Gopobandhu Marg Square and Odisha Secretariat office).

**TABLE I**
Study stretches on routes at a peak hour period

<table>
<thead>
<tr>
<th>Routes</th>
<th>Route Name</th>
<th>Distance</th>
<th>Average Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Power House-Gopobandhu Square-Rabindra Mandap-PMG Square-Master Canteen</td>
<td>2.1 km</td>
<td>10 Minute</td>
</tr>
<tr>
<td>R&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Power House Chowk-Odisha Secretariat-A.G Square-PMG Square-Master Canteen</td>
<td>2.8 km</td>
<td>12 Minute</td>
</tr>
<tr>
<td>R&lt;sub&gt;3&lt;/sub&gt;</td>
<td>Power House Chowk-Odisha Secretariat-A.G Square-Rajmahal Square-Master Canteen</td>
<td>3.0 km</td>
<td>13 Minute</td>
</tr>
<tr>
<td>R&lt;sub&gt;4&lt;/sub&gt;</td>
<td>Power House Chowk-Raj Bhaban Chowk-A.G Square-PMG Square-Master Canteen</td>
<td>3.0 km</td>
<td>15 Minute</td>
</tr>
<tr>
<td>R&lt;sub&gt;5&lt;/sub&gt;</td>
<td>Power House Chowk-Raj Bhaban Chowk-</td>
<td>3.5 km</td>
<td>16 Minute</td>
</tr>
</tbody>
</table>

The stretches have six accessible routes, see table-1 all routes with distances between origin to destination. All routes are to measure the distances and time with the help of GPS during peak hour period at morning and evening.

Fig.1 Study Stretch at Bhubaneswar

The stretches have six accessible routes, see table-1 all routes with distances between origin to destination.

All routes are to measure the distances and time with the help of GPS during peak hour period at morning and evening.

### III. METHODOLOGY

The data needed for the present study was collected by conducting a questionnaire survey. The survey used a scoring technique, in which trip makers were asked to mark the levels and rate the parameters out of ten. These ratings were used for calculating the route
utility. Route utilities of the individual passengers were taken for the development of fuzzy rules (if-then rule). Data set generated from fuzzy rules was used to develop an adaptive neuro-fuzzy interface system (ANFIS) for determining utility [5] of the route and also logistic regression method (LRM) determined utility of routs [4].

The collection of necessary information is required by conducting of questionnaire survey and it is conducted at a peak hour period having mixed traffic condition.

A. Data Collection

It is able to collecting of data principal parameters are travel time, Delay time, travel cost, traffic safety, traffic congestion, traffic safety. The survey used a scoring technique and it was conducted over two stages; the score stage and the numeric levels identification stage. In the score stage, participants were asked to assign scores to the factors mentioned in the questionnaire.

The factor score represents the degree to which the participant’s route choice decisions are affected by such a factor. The level score reflects the preference to undertake a route exhibiting this particular level. The modelling approach adopted is based on the assumption that the route utility perceived by the traveller is equal to the sum of the products of the factor scores and the perceived level scores.

Data are collected at the time of survey and the road attributes (Beneficial and Non-Beneficial) Fig.2 are considered.

Fig.2 Route choices parameters at study stretch

B. Warrant Check

According to Indian Road Congress Warrant Check for the Installation of Traffic Signals [4] on particular traffic intersections. It is required minimum three warrants are satisfied for design and Installation of Traffic Signals. So, warrants are given bellow

- Warrant 1-Minimum vehicular volume
- Warrant 2- Interruption of continuous traffic
- Warrant 3-Minimum pedestrian volume
- Warrant 4-Accidental experience
- Warrant 5-Combination of warrants

| TABLE II |
| Warrants check for Installation at Traffic Intersections |

<table>
<thead>
<tr>
<th>Traffic Intersections</th>
<th>Warrant Status</th>
<th>Installation of Traffic Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power House Chowk</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
<tr>
<td>Gopobandhu Marg</td>
<td>Not-Satisfied</td>
<td>No</td>
</tr>
<tr>
<td>Rabindra Mandap square</td>
<td>Not Satisfied</td>
<td>No</td>
</tr>
<tr>
<td>PMG Square</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
<tr>
<td>Raj Bhaban Square</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
<tr>
<td>A.G Square</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
<tr>
<td>Odisha Secretariat Square</td>
<td>Not Satisfied</td>
<td>No</td>
</tr>
<tr>
<td>Raj Mahal Square</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
<tr>
<td>Master Canteen Square</td>
<td>Satisfied</td>
<td>Yes</td>
</tr>
</tbody>
</table>
C. Analysis of Data

Analysis of data using Adaptive Neuro-fuzzy Interface System (ANFIS) and Logistic regression method (LRM) [1,10]. So, these two methods provide best optimum solutions for route choice.

1) Adaptive Neuro-Fuzzy Interface System (ANFIS): The ANFIS is representing a neural network approach [5,9] for route choice solution of function approximation problems on a particular route. Basically, ANFIS is typically based on clustering a training set of numerical samples of the unknown function to be approximated. It has been successfully applied to classification of a particular tasks, rule-based (If-Then rules) process control at compilation of data. Here all parameters (travel time, travel cost, delay time, traffic safety, traffic congestion etc.) are associated with the membership functions change through the learning process. These are parameter are input into systematic manner in ANFIS.

Route preferences as score based at the time of survey as given by travellers were used as output and compared against the predicated preference value for each of the traveller. Thereby use of ANFIS we need find about observed and predicted values finally.

Finally, I get that ANFIS both predicted and observed value are very close to each other. The root mean square error (RMSE) and Theil’s error value was found to be 0.0841 and 0.0692, respectively. Therefore, ANFIS also performs better at individual level. The final route-wise observed and predicted probabilities are given below in Table III.

<table>
<thead>
<tr>
<th>Routes</th>
<th>Route Choice By Survey, % (Observed)</th>
<th>Route Choice by ANFIS, % (Predicted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_1</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>R_2</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>R_3</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>R_4</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>R_5</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>R_6</td>
<td>11</td>
<td>13</td>
</tr>
</tbody>
</table>

2) Logistic Regression Method (LRM): Logistic Regression provide best solution in binomial situation in Route Choice. For each and every routes have an independent Logistic Regression was formed. In case of LRM selected route was denoted with 1 and non-selected route was denoted with 0. So, there by calculation of Logistic Regression choice probability (P) is given as

\[
P = \frac{1}{1+e^{-(b_0+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5)}}
\]

Where,

P is the probability of chosen
x_1 - Travel cost
x_2 - Travel time
x_3 - Delay time
x_4 - Traffic congestion
x_5 - Traffic safety and b_0, b_1, b_2, b_3, b_4, b_5 are regression factors.

Here all the survey data was analysed with the help of LRM, which is the best statistical method used for binomial situations and regression factors are found table 1 there by the help f regression factor found out route choice

As the result of maximum likelihood method used for estimation of logistic parameters and level of significance of the models is to determined using chi-square test is used for goodness of fit, significance of observed parameters.

D. Result and Discussion
The results of ANFIS and LRM [12,13] are compared considering the training and test set. If the route, which logistic regression result showed as route choice value and real selected one, are the same, this meant the compatibility between FL and real data is computed. The function used for this accuracy computation is:

\[ \text{Accuracy\%} = \frac{100}{N} \sum_{n} y_n \]

Here, N is the Number of examples, \( Y_n = 1 \), If \( n_{th} \) individual’s choice in survey and model result is the same otherwise zero.

<table>
<thead>
<tr>
<th>Destination</th>
<th>LRM (%)</th>
<th>ANFIS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training Data</td>
<td>Test Data</td>
</tr>
<tr>
<td>R₁</td>
<td>45.00</td>
<td>46</td>
</tr>
<tr>
<td>R₂</td>
<td>60.00</td>
<td>60</td>
</tr>
<tr>
<td>R₃</td>
<td>75.23</td>
<td>76</td>
</tr>
<tr>
<td>R₄</td>
<td>83.27</td>
<td>84</td>
</tr>
<tr>
<td>R₅</td>
<td>93.50</td>
<td>93</td>
</tr>
<tr>
<td>R₆</td>
<td>99.59</td>
<td>100</td>
</tr>
</tbody>
</table>

For the validation of the Models are investigated before comparisons. Now, the training data are used for validation search. Here accuracy rates of NFIS and LRM for training data are reasonable Table-V, therefore both of this models are used in modelling route choice [8] at a traffic conditions.

Now, both ANFIS and LRM results are also compared with real data in order to search proper validation. Here 300 data are taken for validation search. Comparison Table-V of accuracy checking of ANFIS and LRM's Results shows that ANFIS provides higher accuracy rates then LRM.

IV. CONCLUSIONS

Soft comparing with the help of Matlab in ANFIS and LRM demonstrate optimal value for best choices at heterogeneous traffic condition. As the results of ANFIS approach are more realistic because of its Characteristics on modelling imprecision and uncertainty in routes choice.

The accuracy of ANFIS for route choices are higher as compared to LRM (Table-5) and the value of observed data and predicted data are realistic (Table-III).

So, here we compering of ANFIS and LRM methodology fond out Route-1(R₁) is best route for this study stretches as compared to other routes.

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