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Travel Demand Modeling and Forecasting

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Abstract : Travel demand forecasting is that the premise of any urban or sub urban planning project. Forecasting models have become used for projecting future traffic and defines whether there's a requirement of recent road network or transit mode or land use policies. Modeling involves a series of mathematical models that just simulates human behavior. Modeling is completed by completing different processes and answering the series of questions on human behavior. Many attempts are being made to simulate all choices that traveler make in response to given system of highways. As no model is nice assumptions are to be made about decisions by traveler. the strategy of traffic modeling follows the steps as generation of trips in zones, moving through various nodes, through a network of links and ends at attracting zone. This modeling process is believed as Four step modeling. These four steps are as Follow-Trip Generation, Trip Distribution, Mode choice and traffic assignment. This paper deals with four step modeling within the context of Sitapura industrial area with the entire Jaipur city, Rajasthan

I. INTRODUCTION

Travel forecasting models are accustomed anticipate changes in traffic patterns so the use of the installation in counter to changes in regional development, and road networks supply. Travel demand modeling are often a challenging task, but it's required for perceptive planning and analysis of transportation systems [1]. Transportation planning involves the decision-making process for possible improvements to a community's roadway infrastructure. to help within the decision- making process, several computers based and manual tools are developed. Keywords are: a) Travel demand forecasting models for executing the four-step urban planning process b) Travel rate indices for providing congestion and delay information for a community[2]. The four-step planning process accommodates the following: a)Trip Generation)Trip Distribution, c)Mode Choice, and d)Trip Assignment [1]. The objectives of this paper are to look out out about the Urban Transport Modeling System and to understand how better understanding of the behavior of the traffic condition of sitapura industrial region in context with Jaipur area on the zonal basis and to develop the Network Assignment through the Transport Modeling System

II. STUDY AREA

91 wards (the smallest electoral unit) of Jaipur municipal Corporation area are being selected because the study area for this paper (Figure 1).

Figure 1: Jaipur City Ward Map (Source Jaipur Nagar Nigam)

These 91 wards are divided into 15 zones called TAZ (Traffic Analysis Zone) per Jaipur nagar nigam but here we only study about only 8 zones.

III. METHODOLOGY

The conventional four step transportation modeling system is used to attain the objectives of this research paper. it's a macro-level working procedure [3]. the subsequent four steps are to be performed within the next stage:

A. TRIP GENERATION

The very initiative of traditional four step modeling is that the trip generation [1]. It anticipates the number of trips which are originating in or going for a specific traffic analysis zone (TAZ). Trip generation uses trip rates which are averages for large portion of the study area. Trip productions are based upon household characteristics because the amount of individuals living within the household so the amount of vehicles available [1].

Following table show the growth rate source census India 2011 is shown in table 1.

Table 1: rate of growth of population and employment.

Variable	Growth Rate
Population	1.06%
Employment	2.5%

: Source census 2011

Forecasted population data of assorted zones is shown in table 2. Values are calculated using protein data

Table 2: Forecasted population data

ZONE	2011	2020	2030
ZONE A	729676	745913	779480
ZONE B	545583	557724	582822
ZONE C	424564	434012	453543
ZONE D	352980	360835	377073
ZONE E	294880	301442	315007
ZONE F	355523	363435	379790
ZONE G	177918	181878	190063
ZONE H	134428	137420	143604
TOTAL	3015552	3082659	3221382

Calculation process: Population after 10 years (2026): - Existing population (1 .045) ^1

Regression Equation for Trip Production:

Yattraction=a1+.(a2 X population)

Where, a1=4339.50557

a2=.00160249818

By Using these regression equations we calculated forecasted trips, for trip attraction after 10 years.

Table 3: Forecasted Trips for Various Zones

Sr. No.	ZONES	
1	ZONE A	5589
2	ZONE B	5274
3	ZONE C	30836
4	ZONE D	4944
5	ZONE E	4844
6	ZONE F	4948
7	ZONE G	4644
8	ZONE H	4569
TOTAL		65648

Here the primary step of trip generation after forecasting future productions/origin and attractions/destination ends (shown in table 3).

B. TRIP DISTRIBUTION

Trip distribution of the second component within the traditional 4-step transportation forecasting model. during this step origins and destinations to develop are calculated and a "trip table" a matrix that displays the number of trips going from each origin to each destination is developed [1]. Since we are just focusing over Sitapura region where trip production is extremely low therefore only matrix of attraction is created. We are neglecting the assembly trips. (Table4)

Table 4: Distribution of trips

Sr. No.	ZONES	MZ
1	ZONE A	5589
2	ZONE B	5274
3	ZONE C	30836
4	ZONE D	4944
5	ZONE E	4844
6	ZONE F	4948
7	ZONE G	4644
8	ZONE H	4569
TOTAL		65648

By using the formula of generalized cost shown below we can calculated Cost matrix of Cars and Buses.

Table 5: Cost matrix table (C ij) in terms of your time

Zones	A	B	C	D	E	F	G	H
Car	8.38	8.02	4.16	5.87	6.65	6.86	6.68	13.15
Bus	7.14	6.01	3.34	4.39	6.32	5.76	5.65	6.8

here, for calculation purpose,

$$\mathbf{c_{ij} = a\,t_v + a_2\,t_w + a\,t_t + a\,t_n + a_5 F_{ij} + a_6 \varphi_j + \delta}$$

where, a_1 , a_2, a_3, a_4 are .03,.04,.06,.1 respectively (assumed [1])

C_{ij} = Travel General cost between zone i to zone j

C. MODE CHOICE

Mode choice analysis is that the third step of the standard four-step transportation planning process . Trip distribution's zonal interchange analysis may be a set of origin destination tables which states that from where the trips are going to be made; mode choice is that the step which allows the modeler to work out which mode of transport are going to be used for traffic assignment [1]. Mode choice is one among the foremost vital parts of the travel demand modeling process. it's the step where trips between a given origin and destination are divided into trips using conveyance, trips by set or as passengers and trips by two wheelers. A utility function is one which measures the degree of gratification that individuals derive from their choices and a disutility function represents the full generalized cost that's affiliated by each choice of mode [2]. the foremost commonly used process in mode choice splitting is to use the 'Logit' model. This involves a comparison of the "utility" of travel between any two points for the various modes which are available at the zone. Utility may be a term which is employed to represent a mixture of period, cost and convenience of any mode between an origin and a destination. it's found by placing modal parameters or multipliers (weights) on these factors and adding them together [2].Moreover, we assumed utility functions for these three modes. we can calculat utility functions as follows [3]:

$$\mathbf{U_{CAR} = -\,.0230 * TT - .07302 * TC}$$

Where, TT = Travel Time from Zone-1 to zone-2

TC = Travel cost from Zone-1 to zone-2

Using these equations a utility matrix is being developed for bus and car(shown in table 6).

Table 6: Utility Matrix Table for Car and Bus

Zones	A	B	C	D	E	F	G	H
Car	4.19	4.01	2.08	2.935	3.325	3.43	3.34	6.575
Bus	3.57	3.05	1.67	2.195	3.16	2.88	2.825	3.4

$$\mathbf{P_{ij1} = T_{ij1}/T_{ij} = e^{-bc_{ij1}} / e^{-bc_{ij1}} + e^{-bc_{ij2}}}$$

Where, b=.5(assumed)

Here C_{ij} = Generalized Cost of various modes.

Table 7: Probability Matrix for Bus and Car.

Zones	A	B	C	D	E	F	G	H
Car	0.3497	0.2679	0.3989	0.323	0.4588	0.3658	0.374	0.0401
Bus	0.6502	0.7321	0.6011	0.677	0.5412	0.6342	0.626	0.9599

Modal share is calculated by the merchandise of the trip making from one zone to other zone (from trip distribution) with the probability (table 8). this can be calculated as:

Any Mode Modal Share = Trip{i}{j} X Probability of mode.

Table 8: Bus And Car Modal Share Matrix.

Zones	A	B	C	D	E	F	G	H
Car	1954	1412	12306	1596	2222	1809	1736	183
Bus	3635	3862	18536	3348	2622	3139	2908	4386

D. TRIP ASSIGNMENT

Trip assignment, affects the choice of routes (or paths) between origin and destination of transportation networks. it's the fourth step within the traditional transportation planning model. Mode choice analysis decides which travelers will use which mode of transport. to see facility needs and costs and benefits, we want to understand the amount of travelers at each route and links of the network [1]. Once trips are split into highway and bus trips, the actual path that they use to travel from their origin to their destination must be found. These trips formed then formed are assigned to that path within the step called traffic assignment [2]. the method initially involves the calculation of the shortest path from each origin to destinations (usually the minimum time path is used). The assigned trip volume is then balanced to the capacity of the link to work out if it's congested. If there's any change in time period, then it's going to also affect the shortest path. Traffic assignment is that the most composite calculation of the travel modeling process and there are number of the way within which it's done to stay commuter time to a minimum [1].

GTC=TC+(a1/a2)TT

Where, TC=Travel Cost,
TT=Travel time,
a1= Co-efficient of the time period factor,
a2= Co-efficient of the Travel Cost factor.

The values a1 & a2 come from the utility functions mentioned earlier within the Modal Choice step.
a1/a2=.3155

Now using the GTC table, the calculated values of GTC for various modes are put into the various links of the assumed network. Thus Generalized time period (GTT) may be calculated from the equation below:

GTT= (a2/a1) * TC + TT

Now by using the Dijkstra's Method the shortest distance in terms of GTC from one node to the opposite node for various mode is calculated. Here all-or-nothing assignment for the calculation of traffic flow for the various modes from one node to other node is calculated. In highly congested areas, or in large urban areas, the quantity of physical highway capacity leads to the spreading at the height hours. While it's uphill for a designed roadway to hold an hourly volume of traffic which is larger than its theoretical maximum capacity, the highway assignment algorithms are commonly used which might produce traffic volumes on the roadways that exceed the capacity.

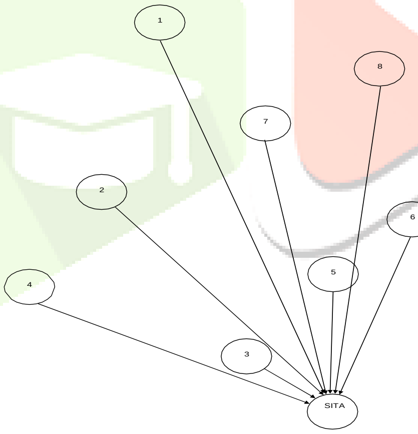

Figure 1: Line Diagram of Study Area.

Generalized distance between different zones is shown in figure 1 as a line diagram.

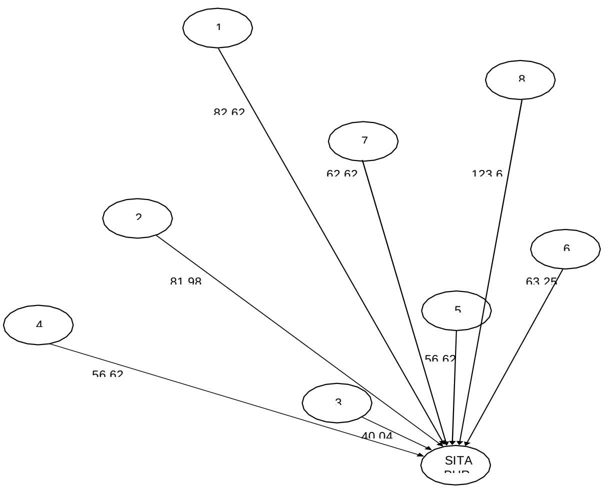

Figure 2- Generalized Cost for Cars

Generalised cost diagram on the bases of Table 5 is shown in figure 2 and figure 3.

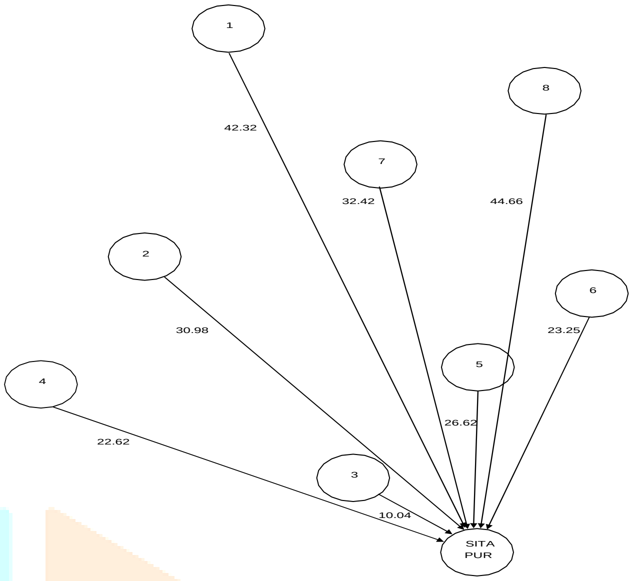

Figure 3- Generalized Cost for Bus

Traffic assignment is completed for peak hour traffic while forecasts of trips are done on a day to day . peak hour traffic ratio to daily travel is to be calculated for convert daily trips to peak hour travel total trips in each link is shown in following table 9. In this report it is assumed that 10% of travel occurs in the peak hour. For this 10% of the flow in peak hours of total trips per link according to their shortest path are calculated for the all two modes Units.

Table 9: Total Trips in each link for various modes

LINK	FLOW FOR BUS	FLOW FOR CAR	FLOW FOR TWO WHEELERS
A-1	112	951	4527
A-2	106	897	4272
A-3	617	5243	2492
A-4	99	841	4004
A-5	97	824	3924
A-6	98	842	4007
A-7	93	790	9762
A-8	90	776	3700

Occupancy of varied modes is assumed consistent with reference [1]

Table 10: Total no. of Modes in each Link at peak hours

LINK	BUS			CAR			TWO WHEELERS		
	OCCUPANCY	FLOW	NUMBER	OCCUPANCY	FLOW	NUMBER	OCCUPANCY	FLOW	NUMBER
A-1	28.5	112	4	1.85	951	514	1.63	4527	2777
A-2	28.5	106	3	1.85	897	485	1.63	4272	2620
A-3	28.5	617	22	1.85	5243	2834	1.63	2492	15288
A-4	28.5	99	3	1.85	841	454	1.63	4004	2456
A-5	28.5	97	4	1.85	824	445	1.63	3924	2417
A-6	28.5	98	3	1.85	842	455	1.63	4007	2488
A-7	28.5	93	3	1.85	790	427	1.63	3762	2111
A-8	28.5	90	4	1.85	776	410	1.63	3700	2144

Number of buses available at peak hour is calculated by using the given formula and is shown in figure 4

Number = Flow/Occupancy

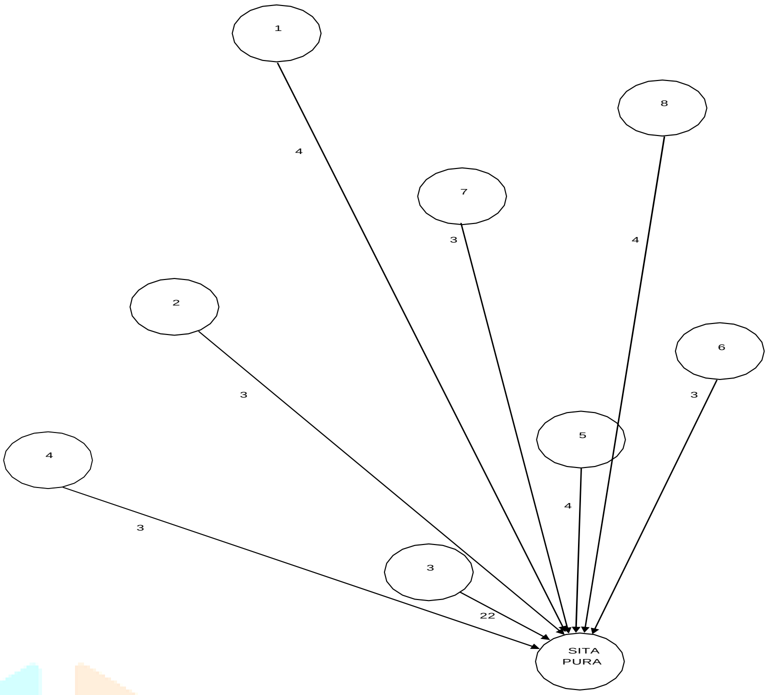

Figure 4: Buses available at the peak hour traffic

IV. CONCLUSION

Transportation models are wont to provide forecasts for a posh set of problems that goes beyond their capabilities and original purpose. Travel demand management, pedestrian and bicycle programs and employer based trip reduction programs may not be handled well in the process. Transportation travel forecasting models use packaged programs of computers which have their own limitations on how easily they can be changed. In some cases, the models can be redesigned to accommodate extra factors or procedures while in other cases major modifications are needed or new software are required. All models are supported data which we offer about travel patterns and behavior. If this data is out-of-date, incomplete or inaccurate, the results will not be good no matter how good the models itself is. One of the best ways of improving model value and accuracy is to have a good data to be used to calibrate the models and to provide for checks for their accuracy. Models need to demonstrate that they provide an accurate picture of current travel pattern before they are to be used to forecast future travel. Better data, improved representation of pedestrian and bicycle travel, better auto occupancy models, use more trip purposes, better time of day factors , better representation of access, incorporate costs into trip distribution, addition of land use feedback, addition of intersection delays- are some important points which should be considered and included in the conventional transport modeling system to make it much more convenient and realistic.

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