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Calibration and Validation of Microscopic Simulation Model of Ambedkar Statue Junction Based on VISSIM

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Abstract: ***VISSIM has become one of the most useful and reliable programs utilized by contemporary engineers and researchers in the processes of evaluation of control operations and strategies of transportation. In this study calibration and validation techniques of VISSIM parameters that derive from the need to accurately match the simulations results of the models with the observed field data. Micro-simulation is a widely used and one of the most effective ways to predict traffic behavior of urban intersections. The advanced microscopic traffic simulator is PTV VISSIM. It has been used to evaluate the peak-hour traffic operating conditions to replicate the total scenario several local vehicles are modelled. The model was duly calibrated using field data and validated using Geoffrey E. Heavers (GEH) statistics comparisons or GEH values, F-Distribution, T-distribution and Chi-squared test. A key component of simulation modeling is the calibration and validation stage of the model building process. Calibration is defined as the adjustment of computer simulation model parameters to accurately reflect prevailing conditions of the roadway network. Validation is defined as the process of comparing simulated model results with field measurements in order to determine the accuracy of the simulation model. In a metropolitan city of a developing country, for instance Ambedkar Statue Junction model has been calibrated from the actual field data and using the outcome the total speed and volume for an intersection of that corridor was estimated.***

Keywords: Calibration, Validation, GEH statistics, F-Distribution, T-Distribution, Chi-squared Test

I. INTRODUCTION

Traffic growth in the road network of large cities in developing countries is a serious concern from the traffic engineer's point of view. Traffic should be a major consideration in the planning of new or expanding developments. Simulation is an important and effective tool to estimate the outcome of any existing or future development on the road network. To do this the developing countries with heterogeneous traffic condition need to use the proper tools which replicate the traffic scenario. Traffic simulation model can be an effective tool in this regard. Microscopic traffic simulation software tools have become increasingly more popular in recent years to analyse traffic operations on freeway corridors. A key component of simulation modelling is the calibration and validation stage of the model building process. Microscopic simulations are widely used in transportation operations and management analysis because simulation is safer, less expensive and faster than field implementation and testing. Similar to other microscopic models of traffic simulation, VISSIM encounters the necessity to calibrate its parameters in order to gain reliability and accuracy of its use by bridging a conditional match of the simulated parameter values with observed traffic field data. Calibration is defined as the adjustment of computer simulation model parameters to accurately reflect prevailing conditions of the roadway network. Validation is defined as the process of comparing simulated model results with field measurements in order to determine the accuracy of the simulation model. The goal of the model validation stage is to identify parameter settings in the simulation model which produce outputs that closely reflect measured field results.

II. STUDY AREA

Ambedkar statue junction is located at Hyderabad the Indian state of Telangana. The Hussainsagar (Tank bund) is located beside this junction. The Telugu Thalli flyover crosses through this junction.

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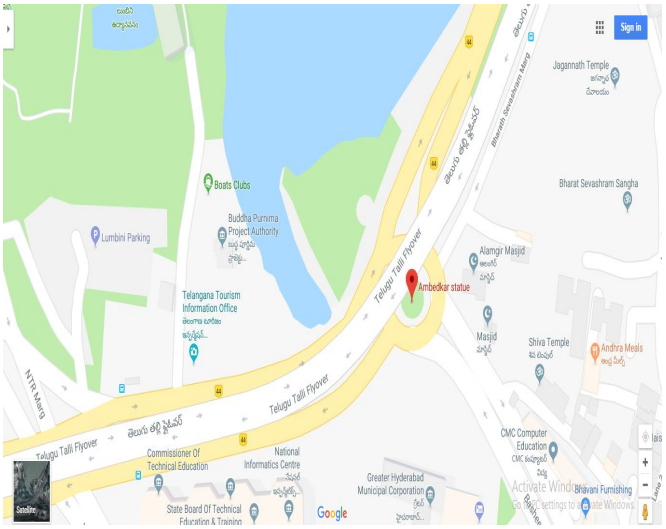


Fig. 1 Ambedkar statue Junction

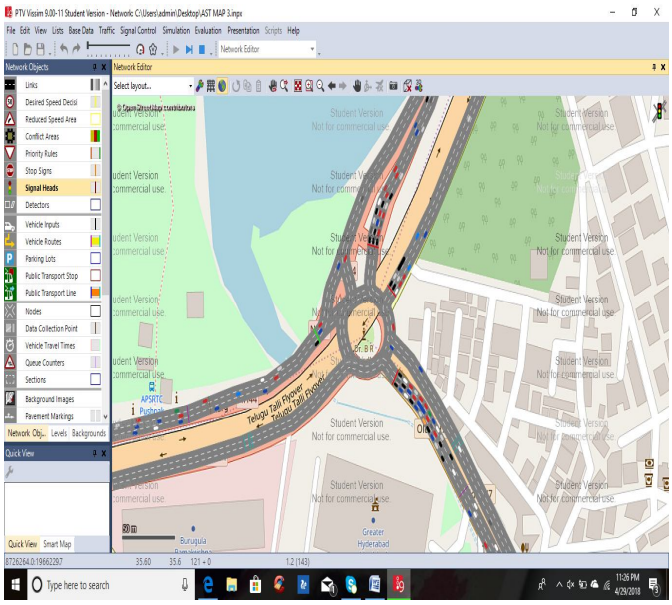


Fig .2 Simulation Run In Vissim

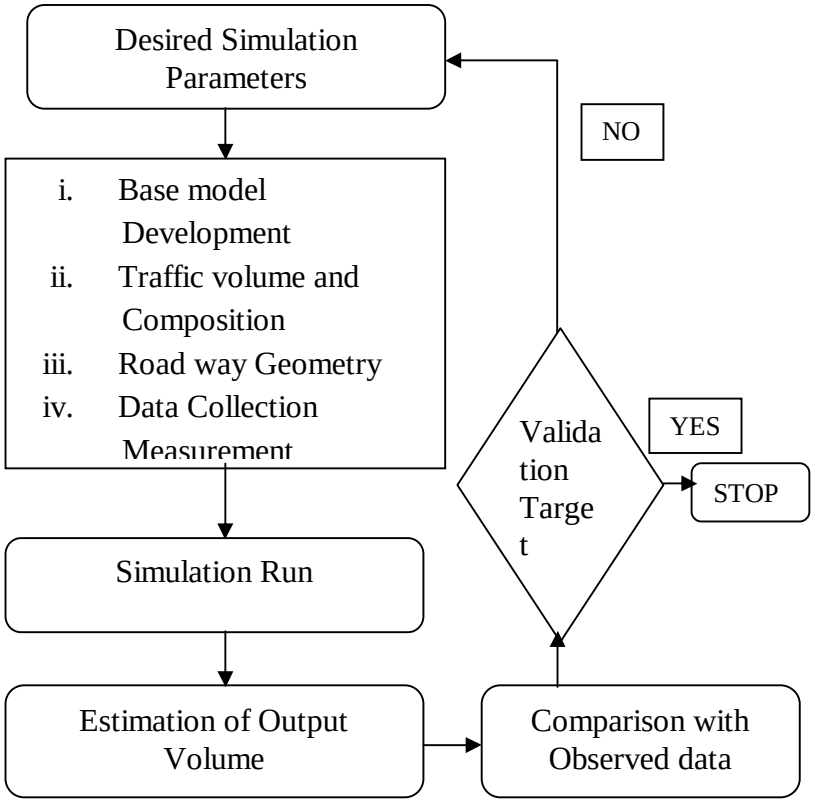
III. OBJECTIVES

The main objectives of the study are as follows

1) To collect the physical features of the intersection using total station and suggesting any improvement if required.
2) AutoCAD is used to show the improvements as per standards.
3) To collect the traffic data by using vehicular volume counts survey
4) To estimate the peak hour vehicles and peak hour PCU's for every leg of Ambedkar statue intersection.
5) To determine the vehicular composition for the intersection.
6) To find the peak hour flow of the intersection.
7) To find the cycle length by using web star method.
8) To check the goodness of fit by using GEH STATISTICS, CHI-SQUARED Test, T-DISTRIBUTION AND F-DISTRIBUTION

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IV. METHODOLOGY



V. RESULTS AND DISCUSSION

Ambedkar statue was selected for concluding various parameters. Total station instrument was used to collect the existing features of the Ambedkar statue intersection. The intersection was improved by providing road markings whereas the other features of the junction were according to the standards

INTERSECTION SURVEY

ROUTE NAME: Liberty to Secretariate (Left)
Volume Counts at Ambedkar Statue Intersection
Day: Monday Date: 16/01/2017
Name of Location: Ambedkar Statue
Type of road surface: Flexible
Name of Enumerator : SONIYA GRACE

PCU'S	0.75	2	1	1.4	4	2.2	2.2	0.4	1.5				
Timing	2w	3w	cars	LCV	HCV	Bus	Mini bus	Cycle	Rickshaw	Total Vehicles	Total PCU's	Peak Hour Vehicles	Peak Hour PCU's
8:00 - 8:15 AM	124	12	54	1	0	0	0	0	0	191	172.4		
08:15 - 8:30AM	137	15	60	0	0	0	0	1	0	213	193.15		
8:30 - 8:45 AM	165	17	62	0	0	0	1	0	0	245	221.95		
8:45 -9:00AM	172	12	64	0	0	0	0	1	0	249	217.4	898	804.9
9:00 - 9:15 AM	189	13	72	1	0	0	0	0	0	275	241.15	982	873.65
9:15 - 9:30 AM	150	10	79	1	0	0	0	0	0	240	212.9	1009	833.4
9:30 - 9:45 AM	120	12	85	1	0	0	0	0	0	218	200.4	982	871.85
9:45 - 10:00 AM	132	9	87	1	0	0	0	0	0	230	205.8	963	860.25
10:00 - 10:15 AM	141	11	100	2	0	0	0	1	0	255	230.95	943	850.05
10:15 - 10:30 AM	127	13	80	2	0	0	1	0	0	223	206.25	926	843.4
10:30 - 10:45 AM	112	12	78	1	0	0	0	0	0	203	187.4	911	830.4
10:45 -11:00 AM	178	10	75	0	0	0	0	0	0	263	228.5	944	853.1
11:00 - 11:15 AM	172	8	69	0	0	0	0	0	0	243	214	938	836.15
11:15 - 11:30 AM	167	7	70	0	0	0	0	1	0	245	209.65	960	839.55
11:30 - 11:45 AM	154	9	68	1	0	0	0	0	0	232	202.9	989	855.05
11:45 - 12:00 PM	148	9	65	0	0	0	0	0	0	222	194	948	820.55
TOTAL	2388	179	1168	11	0	0	2	5	0	3753	3338.8	12393	11032.3

Fig.3 Ambedkar statue Junction

INTERSECTION SURVEY

ROUTE NAME: Liberty to Secretariate (Left)
Volume Counts at Ambedkar Statue Intersection
Day: Monday Date: 16/01/2017
Name of Location: Ambedkar Statue
Type of road surface: Flexible
Name of Enumerator : SONIYA GRACE

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8:30 - 8:45 AM	165	17	62	0	0	0	1	0	0	245	221.95		
8:45 -9:00AM	172	12	64	0	0	0	0	1	0	249	217.4	898	804.9
9:00 - 9:15 AM	189	13	72	1	0	0	0	0	0	275	241.15	982	873.65
9:15 - 9:30 AM	150	10	79	1	0	0	0	0	0	240	212.9	1009	833.4
9:30 - 9:45 AM	120	12	85	1	0	0	0	0	0	218	200.4	982	871.85
9:45 - 10:00 AM	132	9	87	1	0	0	0	0	0	230	205.8	963	860.25
10:00 - 10:15 AM	141	11	100	2	0	0	0	1	0	255	230.95	943	850.05
10:15 - 10:30 AM	127	13	80	2	0	0	1	0	0	223	206.25	926	843.4
10:30 - 10:45 AM	112	12	78	1	0	0	0	0	0	203	187.4	911	830.4
10:45 -11:00 AM	178	10	75	0	0	0	0	0	0	263	228.5	944	853.1
11:00 - 11:15 AM	172	8	69	0	0	0	0	0	0	243	214	938	836.15
11:15 - 11:30 AM	167	7	70	0	0	0	0	1	0	245	209.65	960	839.55
11:30 - 11:45 AM	154	9	68	1	0	0	0	0	0	232	202.9	989	855.05
11:45 - 12:00 PM	148	9	65	0	0	0	0	0	0	222	194	948	820.55
TOTAL	2388	179	1168	11	0	0	2	5	0	3753	3338.8	12393	11032.3

Fig.4 Improved Ambedkar statue junction

1) *Volume Counts:* The traffic volume count is done for every leg (Secretariat to Liberty, Secretariat to Tank bund, Liberty to Tank bund, Liberty to Secretariat, Lower Tank bund to Secretariat, Lower Tank bund to Liberty, Tank bund to Secretariat, Tank bund to Liberty)

INTERSECTION SURVEY

ROUTE NAME: Liberty to Secretariate (Left)
Volume Counts at Ambedkar Statue Intersection
Day: Monday Date: 16/01/2017
Name of Location: Ambedkar Statue
Type of road surface: Flexible
Name of Enumerator : SONIYA GRACE

PCU'S	0.75	2	1	1.4	4	2.2	2.2	0.4	1.5				
Timing	2w	3w	cars	LCV	HCV	Bus	Mini bus	Cycle	Rickshaw	Total Vehicles	Total PCU's	Peak Hour Vehicles	Peak Hour PCU's
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9:00 - 9:15 AM	189	13	72	1	0	0	0	0	0	275	241.15	982	873.65
9:15 - 9:30 AM	150	10	79	1	0	0	0	0	0	240	212.9	1009	833.4
9:30 - 9:45 AM	120	12	85	1	0	0	0	0	0	218	200.4	982	871.85
9:45 - 10:00 AM	132	9	87	1	0	0	0	0	0	230	205.8	963	860.25
10:00 - 10:15 AM	141	11	100	2	0	0	0	1	0	255	230.95	943	850.05
10:15 - 10:30 AM	127	13	80	2	0	0	1	0	0	223	206.25	926	843.4
10:30 - 10:45 AM	112	12	78	1	0	0	0	0	0	203	187.4	911	830.4
10:45 -11:00 AM	178	10	75	0	0	0	0	0	0	263	228.5	944	853.1
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11:15 - 11:30 AM	167	7	70	0	0	0	0	1	0	245	209.65	960	839.55
11:30 - 11:45 AM	154	9	68	1	0	0	0	0	0	232	202.9	989	855.05
11:45 - 12:00 PM	148	9	65	0	0	0	0	0	0	222	194	948	820.55
TOTAL	2388	179	1168	11	0	0	2	5	0	3753	3338.8	12393	11032.3

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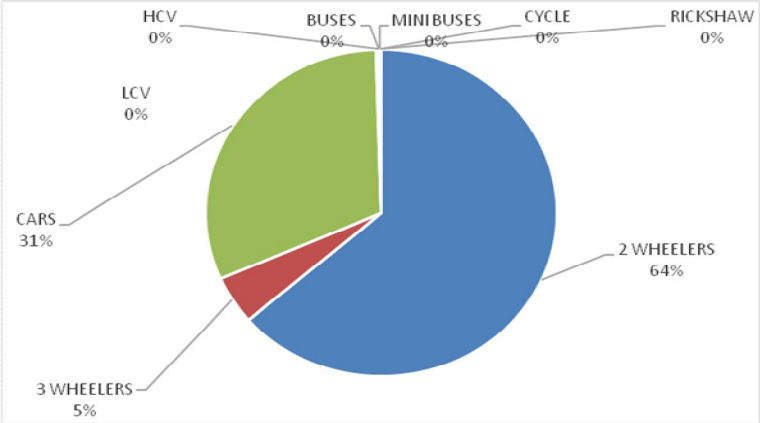


Figure .5 Vehicle Compositions for Liberty to Secretariat

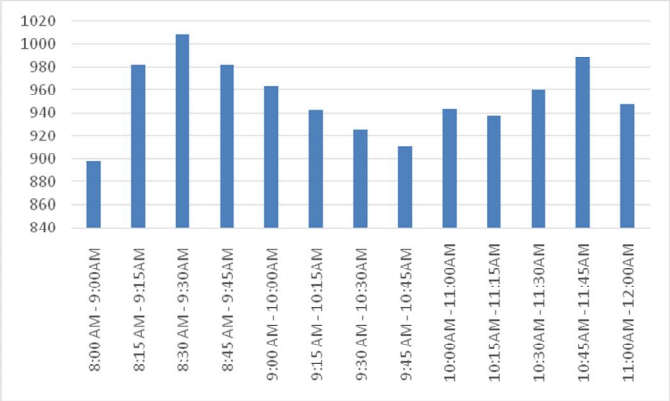


Figure .6 for Time Vs Peak Hour Vehicle

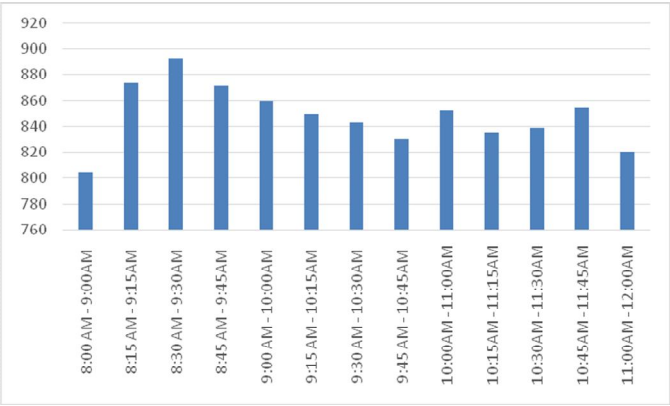


Figure .7 for Time Vs Peak Hour PCU'S

The calibrated ambedkar statue VISSIM model was further validated against field data independent of the calibration data set.Four parameters were used to validate this model

- GEH STATISTICS
- CHI-SQUARED
- F-DISTRIBUTION
- T-DISTRIBUTION

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A. GEH Statistics

This study adopts the Geoffrey E.Heavers statistics to compare field traffic volumes with those obtained from the model.As general guideline for model validation,GEH values less than 5indicate good fit ; values between (5-10) require further investigation ,while values above 10 indicate a poor fit

$$\text{GEH}=\sqrt{\frac{(simulated-observed)^2}{0.5(simulated+observed)}}$$

GEH values of eight approach roads were computed.Table shows the GEH values at different approachesof the junction.

GEH STATISTICS FOR 100 SECONDS

FLOW OF VEHICLES SEGMENT	S.NO	ACTUAL Veh/hr	ACTUAL veh/100 sec	SIMULATION veh/100 sec	ACTUAL SIMULATION Difference(veh/hr)	% DIFFERENCE	GEH
Secretariat to Liberty	1	2009	56	48	539	16.6	1.1
Secretariat to Tankbund	2	569	16	9	299	77.7	1.97
Liberty to Tankbund	3	3015	84	73	825	15.06	1.77
Liberty to Secretariat	4	1009	28	16	529	75	2.55
Lower Tankbund to Secretariat	5	1194	33	21	564	57	2.3
Lower Tankbund to Liberty	6	530	15	7	320	74	2.41
Tankbund to Secretariat	7	2244	67	52	854	28.84	1.94
Tankbund to Liberty	8	1538	43	34	518	26.47	1.45

Six simulation runs with different random seeds were performed to confirm the GEH values.Observed traffic with simulated traffic which is used to calculate GEH values of the Ambedkar Statue Vissim .

B. CHI-Squared Test

A chi-squared test, also written as χ^2 test, a statistical method assessing the goodness of fit between a set of observed values and those expected theoretically. The chi-square test statistic is calculated by using the formula:

$$\chi 2 = \sum (O-E)\ 2/E$$

Where

'*O*' represents the observed frequency.

E is the expected frequency under the null hypothesis and computed by:

$$E = \frac{row\ total \times column\ total}{sample\ size}$$

Comparing the value of the test statistic to the critical value of $\chi 2$ with degree of freedom = (r - 1) (c - 1), and reject the null hypothesis if $\chi 2 > \chi 2$.

If $\chi 2$ (observed) < $\chi 2$ (critical) the observed shows good fit

If $\chi 2$ (observed) > $\chi 2$ (critical) the observed data do not show good fit

The CHI SQUARED is calculated for six simulation runs

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Table: CHI SQUARED For 100 Seconds Simulation Run

From	Actual			Simulation veh/100sec	(Actual-Simulation)/hr diff(veh/hr)	% difference	chi-squared test (X^2)
	Group no	veh /hr	veh/100 sec				
Secretariat to Liberty	1	2009	56	48	539	16.66	1.33
Secretariat to Tank bund	2	569	16	9	299	77.7	5.44
Liberty to Tank bund	3	3015	84	73	825	15.06	1.65
Liberty to Secretariat	4	1009	28	16	529	75	9
Lower tank bund to Secretariat	5	1194	33	21	564	57	6.85
Lower tank bund to Liberty	6	530	15	7	320	74	9.14
Tank bund to Secretariat	7	2414	67	52	854	28.84	4.32
Tank bund to Liberty	8	1538	43	34	518	26.47	2.38
							40.11

Chi squared = $\frac{(O-S)^2}{S}$ =40.11

Degree of freedom v = (m-1) (n-1) = (8-1) (2-1) =7

Where m= number of columns; n=number of rows

$X^2(critical) = 14.07$; X^2(Observed) = 40.11

X^2(Observed) > $X^2(critical)$; The Observed Data do not show Good Fit

C. F-Distribution

In the probability and statistics the F-distribution is also known as snedecors F distribution or the Fisher-snedecor distribution is a conyinous probability distribution that arises frequently as the null distribution of a test statistic

DEGREE OF FREEDOM $V_1 = (n_1-1)$

$V_2 = (n_2-1)$

Equivalently, the random variable of the *F*-distribution may also be written

$$F = S1^2/S2^2$$

$$S1^2 = \frac{(Xi-X)^2}{(n1-1)} \qquad S2^2 = \frac{(Vi-V)^2}{(n2-1)}$$

Where s_1^2 and s_2^2 are the sums of squares S_1^2 and S_2^2 from two normal processes with variances σ_1^2 and σ_2^2 divided by the corresponding number of degrees of freedom, v_1 and v_2 respectively

$F > F_i$ The difference is significant

$F < F_i$ The difference is not significant

The F -Distribution is calculated for six simulation runs

Table: F-DISTRIBUTION For 100 Seconds Simulation Run

Xi	(Xi-X)	$(Xi-X)^2$	Yi	(Yi-Y)	$(Yi-Y)^2$
56	13.25	175.5	48	15.5	240.25
16	-26.75	715.5	9	-23.5	552.25
84	41.25	1701.5	73	40.5	1640.25
28	-14.75	217.5	16	-16.5	272.25
33	-9.75	95.06	21	-11.5	132.25
15	-27.75	770.06	7	-25.5	650.25
67	24.25	588.06	52	19.5	380.25
43	0.25	0.0625	34	1.5	225

$$F = S1^2/S2^2$$

$$S1^2 = \frac{(Xi-X)^2}{(n1-1)} = \frac{4263.2}{(8-1)} = 909$$

$$S2^2 = \frac{(Yi-Y)^2}{(n2-1)} = \frac{2056.75}{(8-1)} = 293$$

$$X = \frac{56+16+84+28+33+15+67+43}{8} = 42.75$$

X= 42.75; Y= 32.5

$$F = \frac{909}{293} = \mathbf{3.10}$$

$\mathbf{F_i = 2.88}$

$F > F_i$ the difference is significant

D. T –Distribution

The t-distribution plays a role in a number of widely used statistical analyses for assessing the statistical significance of the difference between two sample.

The degree of freedom (V= $n_1 + n_2$-2) can be defined as the distribution of the location of the sample mean relative to the true mean divided by the sample statndard deviation,after multiplying the standard term $\sqrt{n}$. In this way the t-distribution can be used to construct a confidence interval for the true mean.

$$S = \frac{\Sigma(Xi-X)^2+\Sigma(Yi-Y)^2}{n1+n2-2}$$

$$T = \frac{X-Y}{\sqrt{S}\left(\sqrt{\frac{1}{8}+\frac{1}{8}}\right)}$$

T > Ti the difference is significant

T < Ti the difference is not significant

The T-Distribution is calculated for six simulation runs

Table: T-DISTRIBUTION For 100 Seconds Simulation Run

Xi	(Xi-X)	$(Xi-X)^2$	Yi	(Yi-Y)	$(Yi-Y)^2$
56	13.25	175.5	48	15.5	240.25
16	-26.75	715.5	9	-23.5	552.25
84	41.25	1701.5	73	40.5	1640.25
28	-14.75	217.5	16	-16.5	272.25
33	-9.75	95.06	21	-11.5	132.25
15	-27.75	770.06	7	-25.5	650.25
67	24.25	588.06	52	19.5	380.25
43	0.25	0.0625	34	1.5	225

Degree of freedom v = (n_1+n_2-2)

=8+8-2 =14

T_i (for 14 d. f =1.76)

$$X = \frac{56+16+84+28+33+15+67+43}{8} = 42.75$$

$$Y = \frac{48+9+73+16+21+7+52+34}{8} = 32.5$$

$$S^2 = \frac{\sum(Xi-X)^2+\sum(Yi-Y)^2}{n1+n2-2} = 451$$

$$T = \frac{X-Y}{\sqrt{S}\left(\sqrt{\frac{1}{8}+\frac{1}{8}}\right)} = 1.85$$

Ti =1.76

T > Ti

The difference is significant

VI. CONCLUSION

Ambedkar statue was selected for concluding various parameters. On the basis of on-site traffic data collection the peak hour volume, peak hour timing and vehicular composition of Ambedkar statue junction were calculated

- Peak Hour Volume: The peak hour volume for Liberty to Tank bund was found to be 3150 veh/hr
- Peak Hour flow: The peak hour Timings for Liberty to Tank Bund was found to be 10:00-11:00 AM

A. Vehicular Composition

Vehicle composition for 2-wheelers, 3-wheelers, cars, buses are as follows:

2-wheelers were observed to be 54% to 64%, 3-wheelers were 5% to 15%, Cars were 22% to 36%, and Buses were 3% to 5%

The volume of the Ambedkar statue Junction is calibrated and validated by using the following four methods and is checked for goodness of fit

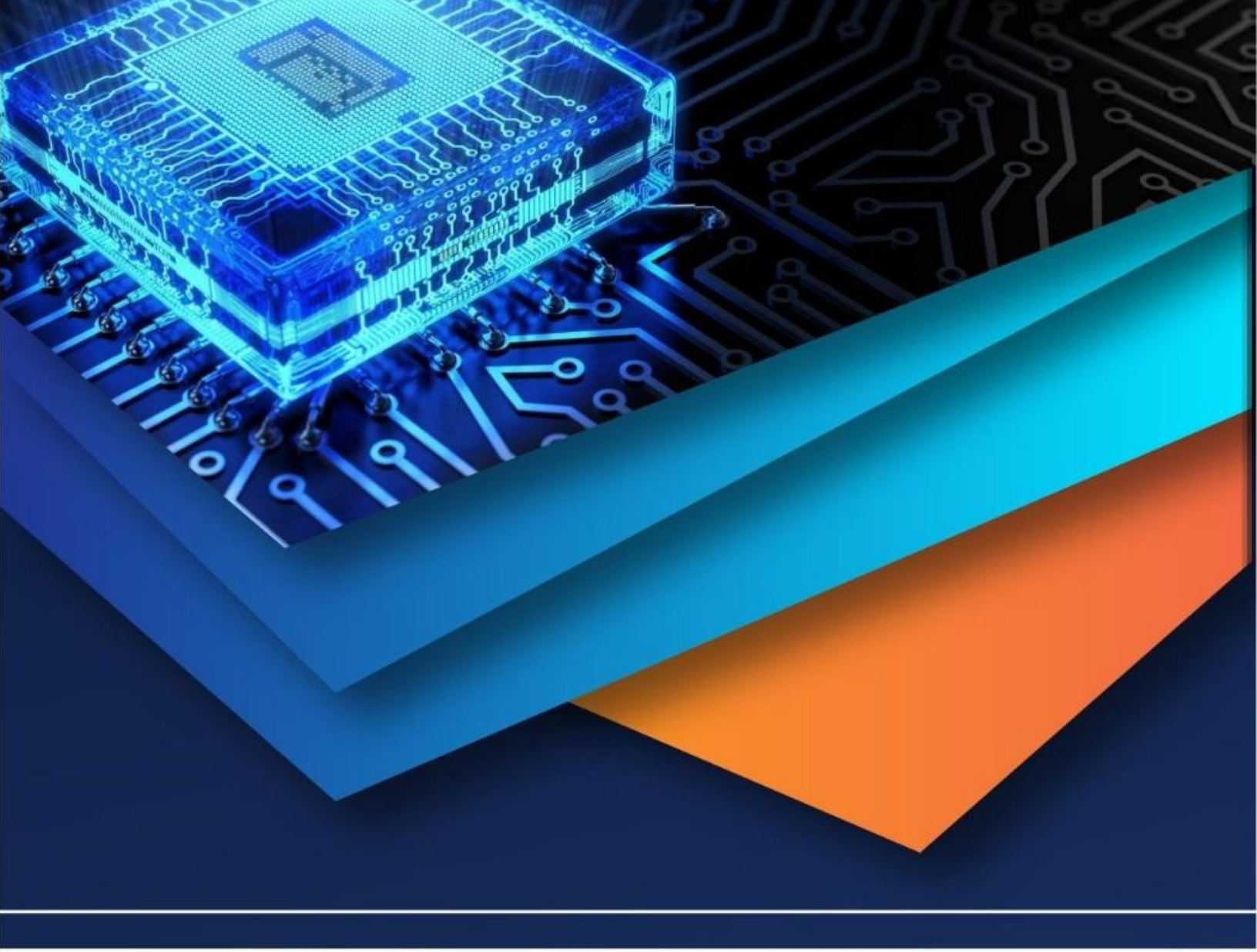
1) GEH Statistics: The GEH values varies from 1.73 to 3.78 for peak hour traffic flow.The GEH values varies from 1.34 to 2.10 for non peak hour traffic flow.Observed traffic with simulated traffic data is used to calculate GEH values of the AMBEDKAR STATUE JUNCTION inVISSIM .The GEH values are less than 5.0 which indicate good fit.The difference between the observed and simulated traffic volume varies from 12.79% to 34.78 % for peak hour flow.For non peak hour flow the difference varies from 7.50 % to 32.48% Therefore,the GEH statistics is recommended for further statistical studies
2) CHI-Squared Test: From the observed and simulated data . $\chi 2$ (observed) > $\chi 2$ (critical) the observed data do not show good fit. Therefore, it is not recommended for further studies
3) F-Distribution: From the observed and simulted data. F(Simulated) > F_i(Observed), therefore the difference is significant. Therefore ,the F-Distribution indicate good fit.It is recommended for further statistical studies
4) T-Distribution: From the observed and simulated data. T (Simulated) > T_i(Observed) ,therefore the difference is significant. The T-Distribution indicate good fit. It is recommended for further statistical studies

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