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Traffic impact assessment for hanamkonda city

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***Abstract*— New development sites can impact the surrounding roadway system by adding to existing traffic volumes or altering traffic patterns. In addition to designing appropriate access for proposed developments, planners and developers should strive to maintain a satisfactory level of transportation service and safety for all roadway users. The Traffic Impact Study will provide guidance for site access, on site circulation, parking, and offsite improvements necessary to permit the street system to operate at a satisfactorily level of service. The present study presents a new trip generation equations and distribution model for traffic impact analysis for site development. The trip rate for proposed development is computed and trip distribution has been carried out using a correlation coefficient distribution model that is evaluated by the traffic patterns of the total trips generated from study area and the inbound or outbound traffic passing through the street link. The objectives of the study is to assess (i) whether the development will meet the City's Minimum Transportation Standards for roadway capacity and safety; and (ii) Mitigating measures necessary to alleviate the capacity and safety impacts so that Minimum Transportation Standards are met using the correlation coefficient distribution model.**

***Keywords*— Traffic Impact Assessment (TIA), Traffic Impact Study (TIS).**

I. INTRODUCTION

A. General

The purpose of a Traffic Impact Assessment (TIA) study is to determine the transportation impacts a particular development will have on the existing roadway network system. A TIA study identifies the need for any improvements and mitigating measures to the adjacent and nearby roadway system to maintain a satisfactory Level of Service (LOS) and safety of the roadway network in the vicinity of the proposed development.

It also identifies improvements needed to integrate the proposed development within the pedestrian and cyclist pathway system. A TIA study is required whenever a development proposal has a significant impact on traffic operations and on other components of the transportation system. The scope of the TIA study may vary depending on the magnitude of the potential impact on the roadway system due to the proposed development.

B. Objectives of the Study

The overall objective of the study is to develop a methodology or model for evaluating the impact of the commercial developments like multiplexes, offices and multi-storeyed residential buildings. The specific objectives are as follows:

- To carry out the evaluation of commercial development being examined under consideration.
- To develop a model, based on the above study to evaluate traffic impacts for such multiplexes or buildings in future.
- To propose guidelines for planning and designing upcoming commercial by the developments including land uses.

The new trips due to development are to be distributed using traffic count based distribution model. Traffic count distribution model is developed according to the relationships between the site origin-destination (OD) and the link traffic counts of the surrounding roadways.

II. METHODOLOGY

A. General

Consistent with the TIA process, the step-by-step manner in carrying out the TIA study for a development project is shown in the flow chart below. It is crucial to follow each step of the process since they are related.

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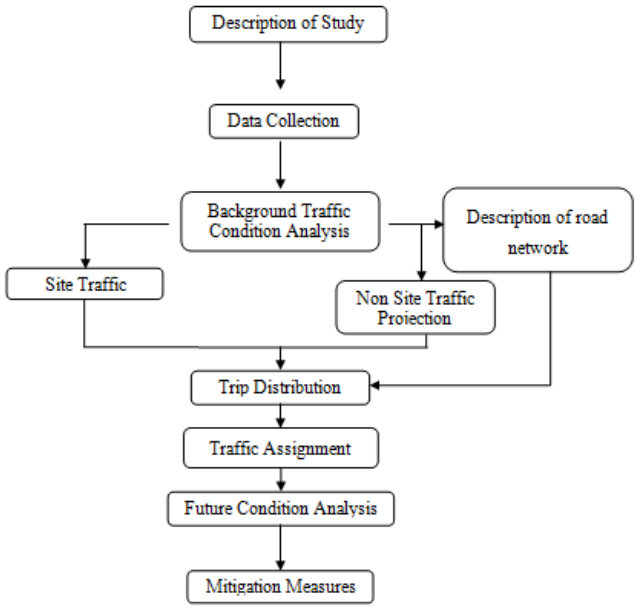

Figure 1|1: Flow chart representing the study methodology

B. Study Area Identification

Based upon the development, the study area has been identified. At a minimum the area to be studied shall include any intersection of "collector" or higher classified streets an which proposed development will add 50 or more peak hour trips up to a 5km radius of project location.

A brief description of the site shall include, as a minimum, a description of its size. General terrain features, existing zoning and use. Provide a map showing build out conditions of the development site including the following:

- Street System
- Roadway classifications
- Number of travel lanes
- Street widths and lane widths, if applicable
- Existing and proposed Right of way (ROW) dimensions
- Existing and proposed multi-use driveways and site access points (with turning movements)
- Existing and proposed sidewalks and bike lanes.

Similar information for adjacent property shall be provided as well, if available, on the same map. The data presented shall be identical in every respect to the site plan submitted for development approval. For situations where a site plan does not exist, a prototypical site roadway and access system should be assumed for purposes of the study. Subsequent update will be necessary when a site plan becomes available.

III. Study Area And Data Collection

A. Study area Description

The study area for the present study was selected in Hanamkonda city, which had three major Central Business Districts (CBD) namely Kazipet, Hanamkonda and Warangal. The traffic plying on these roads are heterogeneous in nature. The traffic mainly consist two wheelers and three wheelers.

The development lies near to the Hanamkonda Bus station. The surrounding roadway has a carriage way width of 7.5 meters without median.

A new mall and multiplex was built and is in operation since November 2012. The development contains 16000 sqft areas for shopping which includes Reliance trends, Kalamandir and Taruni. Multiplex theatre was built on third floor with GFA of 18000 sqft area which constitutes 3 screens and a common food court. A food court was built on second floor with 6300 sqft area along with Funzone on either side of food court.

B. Data collection

Since parameters are established in the methodology development sep, the traffic impact analysis begins with data collection for the same. The various data to be collected for site impact analysis are given below.

1. For existing condition analysis the traffic volume account data in different links have been collected.
2. Trip generation studies has been carried out in different development near the new development having similar characteristics for developing trip generation raes and equations.
3. The morning peak hour and evening peak hour, 15 minute interval turning movement count data collected for 15 intersections.

C. Operational Analysis

For site impact analysis, capacity analysis should be performed along each segment of the roadway system within the area of influence for existing conditions. These facilities include the major street segments, site access locations and intersections within the study area. Total 37 roadways are considered for capacity analysis. The V/C ratio is calculated.

D. Traffic Data

The traffic data for each link is counted for both morning and evening peak hours and is given in Tables 4.1. Morning peak hour is selected as 9.00 to 10.00 a.m and evening peak our as 6.00 to 7.00 p.m.

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Table 3.1
Traffic volume for morning peak hour and evening peak hour

		9.00-10.00 a.m		6.00-7.00 p.m	
Inter section	K	$V_{k(in)}$	$V_{k(out)}$	$V_{k(in)}$	$V_{k(out)}$
1	1	263	285	364	334
	2	238	245	319	317
	3	97	143	143	172
2	4	158	124	179	136
	5	653	587	529	556
3	6	734	561	771	703
	7	282	317	320	332
	8	220	196	181	199
4	9	89	212	102	301
	10	189	221	246	291
	11	400	54	450	133
5	12	412	121	540	189
	13	120	112	174	131
6	14	98	45	86	81
	15	212	283	209	333
	16	1144	1021	1021	1231
7	17	618	619	791	726
	18	791	481	831	512
8	19	213	177	245	215
	20	793	1552	925	1553
9	21	1703	1675	1697	1695
	22	154	159	130	129
10	23	844	951	1010	832
	24	163	144	191	160
	25	94	93	78	66
11	26	361	429	295	378
	27	1199	1251	1140	1251
12	28	121	120	145	143
	29	1811	1668	1713	1670
	30	106	90	121	126
13	31	1312	1271	1293	1251
	32	320	369	282	344
14	33	1811	1520	1659	1657
	34	77	132	88	92
15	35	1460	1311	1742	1307
	36	64	61	90	54
	37	314	453	314	436

E. Trip Generation Rate Surveys

Trip generation is the process used to estimate the amount of travel associated with a specific land use or development. Trip generation is estimated through the use of "trip rates" that are dependent on some measure of the intensity of development, such as gross floor area (GFA) of a particular land use type. Usually ITE specified trip rates are adopted for estimating the newly generated trips. However due to difference inland use and traffic conditions the same rates cannot be accepted. Due to the unavailability of the trip generation rate for Warangal or Hanamkonda city, quantification is required.

As the proposed site consists diverse nature of developments, surveys needs to be conducted at different existing sites exhibiting similar characteristics. Hence to develop the trip rates, the trip generation survey was conducted at the following locations:

i) Megamart ii) Kasams shopping Mall iii)Akshaya
iv) Mangalya shopping Mall v)Ashoka theatre
vi) Vijaya theatre vii) Amrutha theatre viii) Dominos
ix) Sunshine kebabs n chocolate room x) Pizza Corner
xi) US Pizza

In addition to these surveys, survey for origin of the trips, the route which they use along with the timings of the trip is done at the Asian Sridevi Mall (Development for which TIA is being analysed) to cross check the results from trip generation equations as well as trips distributed using Traffic count based Trip Distribution model. Also survey is done to know the percentages of internal trips and pass-by-trips.

IV. Analysis And Results

A. General

A Traffic Impact Analysis begins with trip generation, processing to distribution and assignment, future condition analysis and culminates only after mitigation measures have been suggested. Among these, Trip generation is the most critical element of the site impact analysis. Traffic count based distribution model is used for the distribution and assignment of new generated trips. The future conditions analysis has been done to determine the impact of trips generated by the development on the performance of the transportation system.

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B. Trip Generation

Trip generation is the process used to estimate the amount of travel associated with a specific land use or development. The new trips generated from a site can be calculated based on regression analysis or trip generation rate

a. Trip Generation Rate Analysis

Trip generation equations and rates are prepared based upon the type of land use. The dependent variable trips are represented as a function of independent variable GFA in sqft. The total trips generated from the proposed development are calculated based on the trip generation rate and regression equation. Trip rate estimated using the regression analysis is adopted only if the R-square value is greater than 0.75.

The trip generation equations were prepared for shopping malls, theatres and various food courts. Number of tris generated by the existing Mall is calculated.

b. Shopping complex

From the trip generation survey conducted for different shopping mall's having area varying from 3200 to 12000 sqft, the trips generation equation has been developed for the new Mall. The trips generated from each shopping mall are sown in Table 4.1. The trip generation equations for the shopping mall are shown in the Table 4.2

Table 4.1:
Shopping Complex Areas and Trips

Shopping Mall	Area	Morning peak hr	Evening peak hr	Daily trips
Megamart	3600	5	15	50
Kasam's	5200	8	40	150
Mangalya	10800	12	65	280
Akshaya	12000	15	75	330

Table 4.2:
Shopping Complex's Trip generation Equations

Time period	Shopping complex	
	Regression Equation (Y=Trips and X= Area)	R^2 Value
Morning peak hour	Y=.00925X-2.421642	0.948871
Evening peak hour	Y=.006297X-1.13806	0.9067
Daily	Y=.029664X-33.806	0.945685

c. Multiplex theatre

The trip generation equations are calculated based on the number of seats and thus on theatre capacity (independent variable). The total trips generated from Multiplex are given given in he Table 4.3. The trip generation equation of the multiplex theatre is as shown in Table 4.4

Table 4.3:
Theatre capacity and trips

Theatre	Seats	Capacity /day	Morning peak	Evening peak	Daily trips
Ashoka	880	3520	480	611	2089
Amrutha	875	3500	505	610	2143
Vijaya	779	3116	414	485	1728

Table 4.4:
Theatre Capacity Trip Generation Equations

Time period	Multiplex Theatre	
	Regression Equation (Y= Trips and X= Area)	R^2 Value
Morning peak hour	Y=.196443X-197.3829	0.905162
Evening peak hour	Y= .3180099X-505.783	0.968629
Daily	Y=.97766X-1316.54	0.973382

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d. Food court

Based on other various food courts of similar trip generation characteristics, the trip generation equations have been developed. The trips generated from the food courts are given in the Table 4.5. Trip generation equations for food court are shown in the Table 4.6.

Table 4.5:
Food Court Areas and Trips

Food Court	Area	Morning peak hr	Evening peak hr	Daily trips
Dominos	2000	7	20	90
Sunshine kebabs n chocolate room	1200	3	12	50
Pizza Corner	1200	4	15	60
US Pizza	800	3	9	30

Table 4.6:
Food court's Trip Generation Equations

Time period	Food Court	
	Regression Equation (Y= Trips and X= Area)	R^2 Value
Morning peak hour	Y=.0025526X-.368421	0.892288
Evening peak hour	Y=.00894736X+2.368421	0.92185
Daily	Y=.048684X-5.78947	0.965685

By using the regression equations total trips generated from the development is calculated. The obtained results results are presented in Table 4.7

Table 4.7:
Summary of daily and peak hour Trip Generation

Landuse	Are(sqft)/ Theatre capacity	Morning Trips	Evening Trips	Daily Trips
Shopping Complex	16000	12	100	441
Multiplex Theatre	4620	710	963	3200
Food court	6300	16	59	301
Total		738	1122	3942

e. Estimation of New Trips

Total number of trips generated by a land use is affected by the internal trips and pass-by-trips. Diverted trips are not affected to this land use, since there is no other roadway to provide direct access to the site. For calculating the percentages of pass-by-trips and internal trip rates have been calculated using survey conducted at the Mall.

Table 4.8:
Estimation of morning peak our new trips

Land use	Trips	A	B=A*R	C=A-B	D=C*R	E=C-D
		Total trips	Internal trips	External trips	Pass-by-trips	New trips
Shopping	Entry	12	3	9	1	8
	Exit	0	0	0	0	0
	Total	10	3	8	0	7
Multiplex	Entry	710	0	710	43	667
	Exit	40	0	40	2	38
	Total	750	0	750	45	705
Food court	Entry	16	6	10	1	10
	Exit	0	0	0	0	0
	Total	16	6	10	1	10
Total	Entry	738	8	730	44	686
	Exit	40	0	40	2	38
	Total	778	8	770	46	724

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Table 4.9:
Estimation of evening peak our new trips

Land use	Trips	A	B=A*Rate	C=A-B	D=C*Rate	E=C-D
		Total trips	Internal trips	External trips	Pass-by-trips	New trips
Shopping	Entry	100	24	76	5	71
	Exit	45	11	34	2	32
	Total	145	35	110	7	104
Multiplex	Entry	963	0	963	58	905
	Exit	850	0	850	51	799
	Total	1813	0	1813	109	1704
Food court	Entry	59	21	38	2	35
	Exit	15	5	10	1	9
	Total	74	27	47	3	45
Total	Entry	1122	61	1061	64	997
	Exit	910	16	894	54	840
	Total	2032	78	1954	117	1837

Table 4.10:
Estimation of daily new trips

Land use	Trips	A	B=A*Rate	C=A-B	D=C*Rate	E=C-D
		Total trips	Internal trips	External trips	Pass-by-trips	New trips
Shopping	Entry	441	110	331	20	311
	Exit	441	110	331	20	311
	Total	882	221	662	40	622
Multiplex	Entry	3200	0	3200	192	3008
	Exit	3200	0	3200	192	3008
	Total	6400	0	6400	384	6016
Food court	Entry	301	108	193	12	181
	Exit	301	108	193	12	181
	Total	602	217	385	23	362
Total	Entry	3942	219	3723	223	3500
	Exit	3942	219	3723	223	3500
	Total	7884	437	7447	447	7000

C. Trip Distribution and Assignment

Traffic-count based distribution model is adopted for trip distribution for the present study. The distribution model is developed according to the relationships between the site origin-destination (OD) trips and the link traffic counts of the surrounding roadways.

a. Traffic-Count Based Distribution Model for Site Impact Studies

This new model is based on relationships between the site origin–destination trips and the link traffic counts of the surrounding street system. With this model, the new site-generated trips can be distributed on a particular street link by using a correlation coefficient that is evaluated by the likelihood of traffic patterns of the total trips generated from the study area and the inbound or outbound traffic passing through the street link. Unlike the traditional gravity model, the new model does not rely on land-use data to determine the trip distributions, and is therefore well suited to situations where little or no land-use information is available, such as in developing countries.

In addition, it seems appropriate to consider the correlations between fluctuation patterns of the total existing trips generated from an area and the traffic observed at individual street links within the surrounding road network. It has been observed that if the correlation between the total trips generated from an area and the inbound or outbound traffic surveyed at a particular street link is significant, then there will be a high probability that a trip passing through this link should be from or destined for the area. More importantly, this correlation can also apply to the distribution of the new site-generated trips on each of the street links because of the approximation of traffic patterns between the new site-generated trips and the total existing area trips.

Relationships between Origin–Destination Trips and Link Counts

Consider the situation that no new site is proposed within a study area. All trips presently attracted to or produced from the area are related to the land-use developments that already exist. A centroid is given to represent the terminations of all trips generated within the area. Along its boundary, the entrances of the road network to the area are coded as 1,2,….*k*,…….,*n*. The traffic volumes at each entrance can be obtained from field traffic counting.

Let $T_{k(in)}$, $T_{k(out)}$ be the inbound and outbound trips that are distributed to the *k*th entrance. The total trips originated from or destined for the area are

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Table 4.11
Trips assigned to different links at morning and evening peak hours.

Link No.	Morning		Evening	
	Inward	Outward	Outward	Inward
1	0	0	2	1
2	35	1	54	49
3	2	0	8	3
4	51	3	75	62
5	104	5	138	122
6	6	1	10	8
7	3	0	7	5
8	5	0	4	3
9	141	9	190	162
10	4	1	9	6
11	1	0	3	2
12	168	10	239	205
13	199	13	242	295
14	12	1	18	15
15	24	1	15	22
16	33	1	28	31
17	254	17	365	315
18	40	2	45	50
19	3	0	6	5
20	49	1	59	67
21	145	13	136	154
22	101	10	143	131
23	96	9	128	125
24	2	0	4	3
25	35	2	50	46
26	26	1	32	33
27	6	0	10	9
28	103	7	142	132
29	9	1	14	12
30	76	12	104	98
31	40	6	44	41
32	35	5	32	31
33	5	1	12	10

Operational Analysis

The purpose of the operational analysis for site impact analysis is to determine the impact of trips generated by the development on the performance of the transportation system. The volume to capacity ratio has been calculated and presented in the Table 4.15.

From the table 5.16 it can be understood that due to development the link 7 is affected and V/C ratio is exceeded than 1.

Table 4.12
V/C ratios for Morning and evening peak hours

	Morning peak hour			Evening peak hour		
Link No.	Volume	Capacity	V/C ratio	Volume	Capacity	V/C ratio
1	3663	6400	0.572344	3943	6400	0.616094
2	3474	6400	0.542813	3496	6400	0.54625
3	3916	6400	0.611875	3918	6400	0.612188
4	3691	6400	0.576719	3651	6400	0.570469
5	3020	6400	0.471875	3441	6400	0.537656
6	1522	2200	0.691818	1400	2200	0.636364
7	2310	2200	1.05	2506	2200	1.139091

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8	2289	6400	0.357656	2337	6400	0.365156
9	2710	6400	0.423438	2860	6400	0.446875
10	1165	2200	0.529545	1594	2200	0.724545
11	765	2200	0.347727	1034	2200	0.47
12	2735	6400	0.427344	2938	6400	0.459063
13	3731	6400	0.582969	3820	6400	0.596875
14	3916	6400	0.611875	3918	6400	0.612188

(Capacity values are obtained from CTS HMA)*

D. Mitigation Measures

Since link 7 is the only road link to the development it is most affected. Immediate up gradation of link 7 is required since its volume exceeds the capacity in the present year. As link 7 is falling prone for most of the trips, it has to upgrade in terms of geometrics by providing a median and widening it to 14.5m. From the above table it is observed that in all other routes expect link 7 volumes are not exceeding the capacity. Therefore no mitigation measures are required.

E. Summary

Trip generation equations and rates for the different development are presented in this chapter. From the developed equations the trip generated from the development were calculated. The correlation coefficient has been calculated based on the inbound or outbound traffic passing through this link.

The additional trips are distributed and assigned to the transportation network by using this correlation coefficient. The V/C ratio for 14 road links has been carried out to check the adequacy of the transportation system. Based on operational analysis, mitigation measures are suggested.

V. CONCLUSIONS

Based on the traffic impact analysis conducted, the following conclusions are drawn.

- For developing trip generation equations the gross floor area is considered as the independent variable for shopping complexes and food courts. For multiplex theatre capacity of theatre (number of seats multiplied by the number of shows) is considered as independent variable. Regression analysis is carried out for shopping complexes, food courts and multiplex theatre and the R^2 value obtained is more than 0.75. Hence, it is clear that a significant relation exists between dependent variables and independent variables.
- The traffic count based trip distribution model has been used to distribute and assign the traffic in road network. One of the advantages of this model is that it does not rely on land use characteristics and requires only traffic volume counts. It is therefore observed that the model is suited for small cities where land use data is either unavailable or incomplete.
- The operational analysis has been done for 14 links. The link 7 exceeds the capacity in present year itself. So, mitigation measures as suggested should be implemented.
- Since there is no public transport available to the link 7 in which the development lies, traffic could be reduced by introducing public transport from various links.

A. Scope of further work

The present work can be further extended as indicated below:

- For obtaining the new trips the internal trips and pass by trip percentages are obtained from one day survey conducted at the development. They could be obtained specifically for Warangal city.
- Capacity and LOS analysis could e carried out to determine the critical intersections.
- Since the traffic-count based model is only predicting 70% accurate results, new model could be developed for better results.

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