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MANAGEMENT OF HIGHWAY ROAD CORRIDOR

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Abstract –
The development of cities largely depends upon their physical, social, and institutional infrastructure. In this context, the importance of intra-urban transportation is paramount. This requires both an increase in quantity as well as quality of public transport and effective use of demand as well as supply-side management measures. This paper presents a number of recommendations arising from the road safety study regarding possible improvements in aspects of road safety along the corridor and potential applications of those changes to other roads by studying the overall primary and secondary conditions which impacts on the road corridors of the study area from starting from Kazipet to Warangal road on NH 202.Greater congestion and delays are widespread in Indian cities and indicate the seriousness of transport problems. A high level of pollution is another undesirable feature of overloaded streets. In conclusion urban traffic in India is heterogeneous in character. There is considerable volume of cycle traffic and in some towns cycle rickshaws also ply. Pedestrian traffic is very heavy in urban streets due to high density of population. The very wide variety of traffic units with their great disparity of size and speed creates a number of problems and areas of conflict.

Key words: Infrastructure, corridors, road, transportation, pollution.

I. INTRODUCTION

Cities are the major contributors to economic growth. Movement in and between cities is crucial for improved quality of life. Transport demand in most Indian cities has increased substantially, due to increases in population as a result of both natural increase and migration from rural areas and smaller towns but the rapid growth of traffic congestion on urban roads has become a major concern to transportation professionals [12]. The growing congestion level and resulting additional time, fuel cost, environmental degradation etc., have forced transportation professionals to think of innovative traffic engineering and management measures for mitigation of congestion on urban roads [4]. The growth in population and travel needs will continue and the challenge is for the growth to be handled in ways that don‘t make travel time considerations an undue burden [7]. While congestion in traffic, transit, or other forms will not be eliminated, there are many improvements that can make congestion easier to deal with. Corridor Management deals with some of the ways that are used to reduce congestion and improve the present day travel on a transport corridor [6]. Because of these challenges, Corridor Management Planning (CMP) and related concepts have been proposed.
CMP aims to find solutions to corridor-level mobility and congestion problems via both planning and operational analyses by defining how a travel corridor is performing, understands why it is performing that way, evaluating potential (current and future) improvement strategies through various modelling tools, and recommending system management strategies to address problems within the context of the existing short-term, and long-range planning vision [2].

II CORRIDOR MANAGEMENT

The term corridor management refers to the practice of identifying and implementing a mutually supportive set of strategies to maintain and enhance access, mobility, safety, economic development, and environmental quality along the transportation corridor [8]. A corridor management study or corridor study is a comprehensive assessment of issues, needs, and potential solutions to address these objectives. A corridor study should consider all modes, including transit, bicycling, and walking, as well as automobile and commercial vehicle travel along the corridor [3]. It should consider operational improvements and maintenance as lower-cost, lower-impact alternatives to capital investment strategies [1]. It also should consider land use strategies that address the impacts of growth patterns and local land use decisions on traffic conditions and travel demand [13].Several methods to evaluate a corridor by calculating capacities and volumes on different links, speeds and delays along the corridor [9]. The volume to capacity ratio is measured to get the level of congestion. The speed flow relationships and intersection delay analysis will be helpful tools to the deficiencies and the bottle necks [13]. These tools will enable to evaluate the performance of a given corridor and subsequently to suggest remedial measures for improvements [14].

III. STUDY METHODOLOGY

The present study through which the transportation management study would be completed for the selected area is listed below:

- Identification of the study area
- Physical inventory of the corridors in the study area
- Traffic data collection, Secondary Data Collection
- Evaluating the Corridor using Service Level Benchmarks by MoUD
- Developing NIT Service Level Benchmarks
- Performance Report for all the parameters chosen
- Review of all the available alternatives
- Suggest the best Management Measures

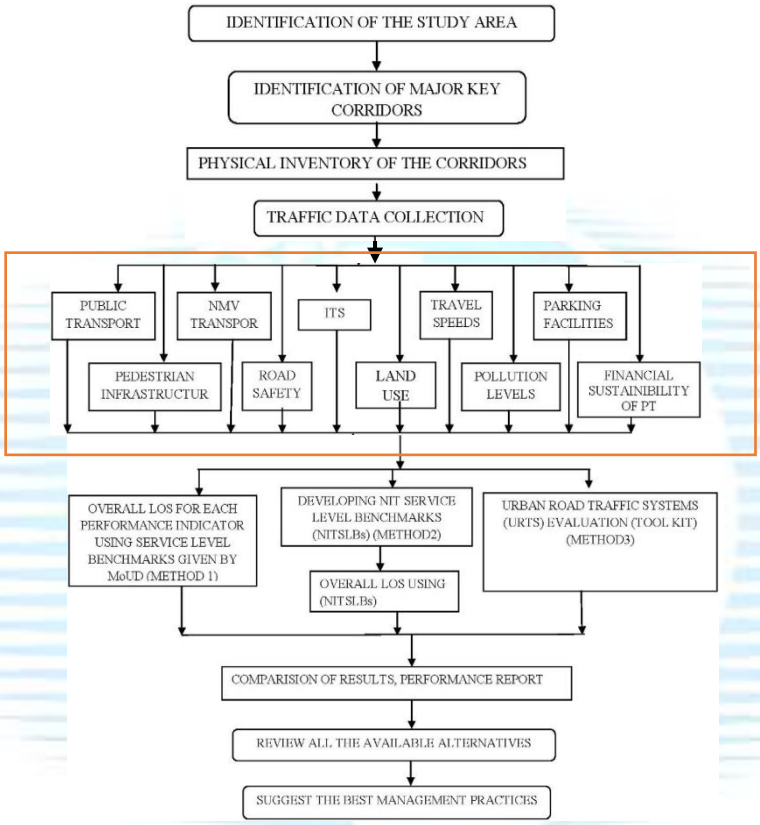

Fig 1: Study Methodology Flow Chart

IV. STUDY AREA

Warangal also known as Orugallu, Telangana Nagaram and Ekasila Nagaram is a city and district headquarters of Warangal district in Indian state of Telangana. Warangal is located about 150 kilometers (92 mi) northeast of the state capital of Hyderabad. Warangal area is a combination of Warangal, Hanmakonda and Kazipet cities. Warangal is the second biggest city next to Hyderabad in Telangana, in the recent past has recorded tremendous growth with increased urbanization as revealed by its population for the decade 1991-2001 and 2001-11. The city is the typical example for ribbon development having one primary road connecting three major settlements, namely; Kazipet, Hanmakonda and Warangal. Hitherto the city‘s development in lateral directions is limited but with the new master plan the overall development of the city is expected in all the directions. It has got limited transport network.

Warangal lies on a major transport corridor and is connected by roads and railways to all parts of the country. Due to its proximity to Hyderabad (150km), the area is important especially around the NH-202 corridor in its south western part. The city is well known for its educational facilities. Warangal city consists of several major institutions like NIT Warangal, Kakatiya University, Kakatiya Medical College, Kakatiya Institute of Technology and Science, Arts and Science College. It is also one of the biggest rice and cotton trading centres.

Transport infrastructure is one of the most important infrastructure facilities in any city and plays a critical role in the growth and development of the city and its surrounding hinterland [5]. Besides providing regional connectivity for movement of people and goods/ commodities to and from the city, the transport infrastructure also guides the spatial growth of the city by connecting the peripheral areas to the city centre which is generally the economic hub. The need to take an integrated long term view of transport needs of Warangal Municipal Corporation and to plan road development, public transport services and

rail transport as a part of the urban planning process is being well recognized as essential for the efficient functioning of the urban system. Peak hour flows on major travel corridors carry heavy traffic volumes. The mixed traffic conditions present additional problems in maintaining lane discipline and hence the lane capacities are far less than those observed in car traffic flows. Fig 2 shows the Warangal City Core area which was taken as study area.

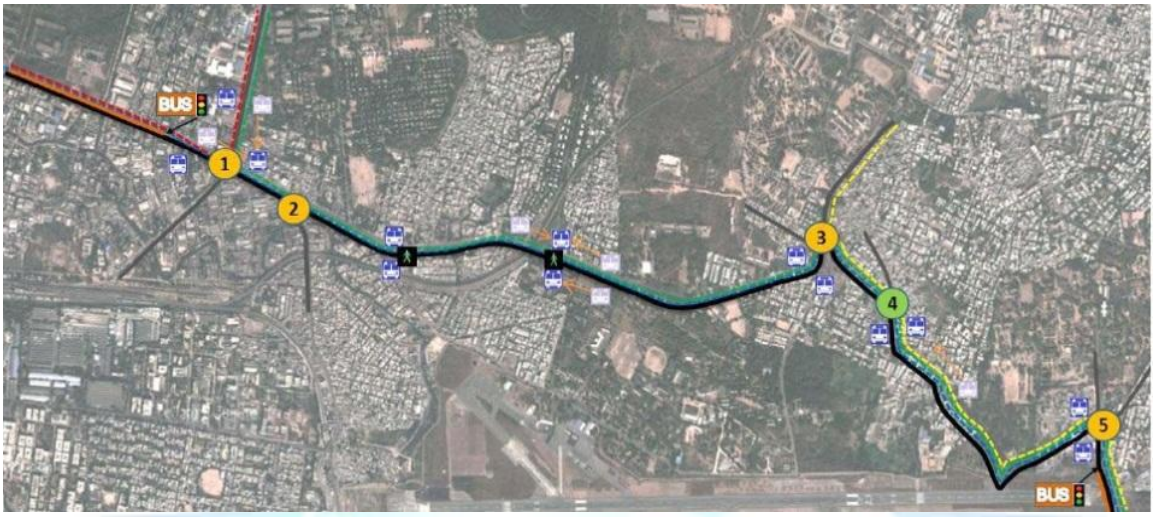

Fig 1: Study Area Map of Warangal

V. DATA COLLECTION

The surveys undertaken for the measurement of Level of Service of each of the Benchmark identified are as follows. The specific surveys are carried out on key public transport corridors, major roads and arterial roads and aggregated to give the overall level of service of the city. This also includes secondary data from different secondary sources. They are listed in the Table 1.

Table I

Areas of Data Collection

nary Surveys	**ondary Data**
ney Speeds & Level of Comfort of Public Transport	ident Data from police records
sical Inventory Data for Foot Path	d Use and Population Data

The Physical Inventory in this study includes the length of footpaths covered in the city and the condition of the footpath. This data was collected on major roads, arterial roads and also sub arterials. A total road length was covered across the city to give the accurate data regarding the footpaths. The data is shown in Fig 3

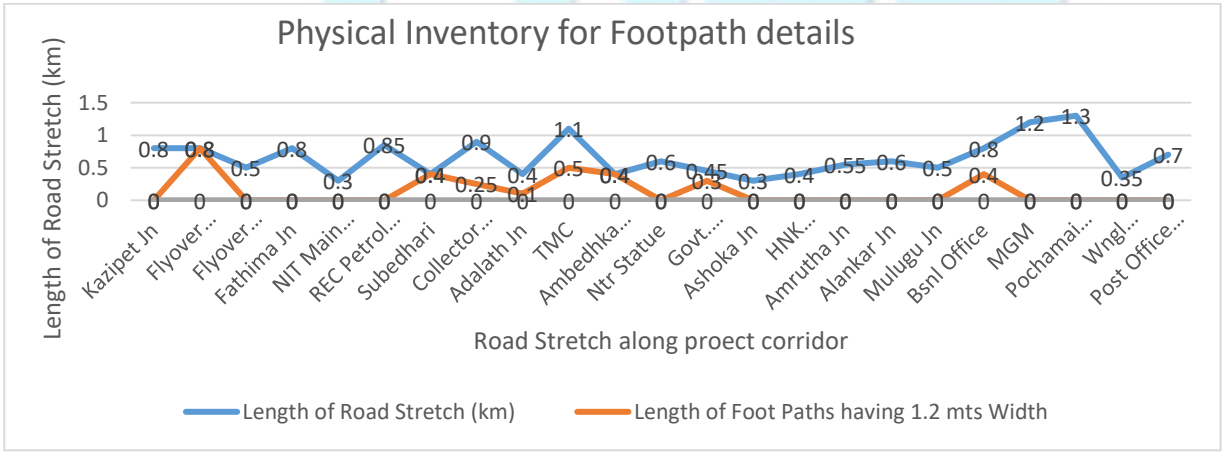

Fig 3: Physical Inventory for Footpath details

Average travel speed of public transport vehicles on the key corridors is strongly influenced by the number of vehicles along the corridor, number of signals per kilometre and the average intersection delay. The Journey Speeds and level of comfort were calculated by travelling in buses on key public transport corridors in the peak hours of public transport. Origin time and destination time were noted to find the travel speeds and passenger count in the buses to find out level of comfort of passengers in the bus. The data is tabulated below in Table 2. The level of Comfort data is summarized in Table II.

Table II

Journey Speeds of Public Transport

S No	Bus Route	Length of the route (km)	Speed (km/hr)	Time in Sec
1	1	0	0	0
2	1	1.8	29	223
3	1	1.3	20	234
4	1	1.5	22	223
5	1	0.6	17	127
6	1	0.6	16	223
7	1	1.3	28	167
8	1	0.5	18	223
9	1	0.7	20	126
10	1	0.7	29	223
11	1	0.9	12	270
12	1	0.6	19	223
13	1	0.7	13	194
14	1	0.8	16	223
15	1	0.5	28	64
16	1	0.5	19	223
17	1	0.8	23	125
18	1	1	19	223
19	1	0.6	9	240
20	3	0	0	223
21	3	1.8	22	295
22	3	0.9	17	223
23	3	1.5	22	245
24	3	0.6	34	223
25	3	0.6	25	86
26	3	1	17	223
27	3	0.6	21	103
28	3	0.8	14	223
29	3	0.8	10	288
30	3	0.4	13	223
31	3	1.1	20	198
32	3	0.5	15	223
33	3	0.4	20	72
34	3	0.4	19	223
35	3	0.2	18	40

S No	Bus Route	Length of the route (km)	Speed (km/hr)	Time in Sec
36	11	0	0	223
37	11	1.8	22	295
38	11	2.6	36	223
39	11	0.4	12	120
40	11	0.8	20	223
41	11	1.6	36	160
42	11	1.2	24	223
43	11	0.7	33	76
44	11	0.5	15	223
45	11	0.9	23	141
46	11	0.8	15	223
47	11	1.4	20	252
48	11	0.6	22	223
49	11	0.8	15	192
50	11	0.8	19	223
51	11	0.5	41	44
52	11	0.5	10	223
53	11	0.8	12	240
54	11	1	17	223
55	11	0.6	23	94
56	11	0.5	10	223

The route number represents the route of the public transport. For example Route no: 3 represents a bus with origin kazipet railway station and destination Warangal city bus stand. The origin and destination time were taken in second‘s format from stage to stage. The average speed of public transport obtained is 19 kmph.

Table III

Level of Comfort Data

S No	Type of Bus	Bus Route No	No. of Passengers in Bus	No. of seats in Bus	Level of Comfort
	inary				)
2	Ordinary	1	35	41	0.85
3	Ordinary	1	52	41	1.27
4	Ordinary	1	53	41	1.3
5	Ordinary	1	54	41	1.31
6	Ordinary	1	46	41	1.12
7	Ordinary	1	41	41	1
8	Ordinary	1	30	41	0.73
9	Ordinary	1	19	41	0.46
10	Merupu	1	28	39	0.72
11	Merupu	1	28	39	0.72
12	Merupu	1	26	39	0.67
13	Merupu	1	24	39	0.62
14	Merupu	1	66	39	1.7

S No	Type of Bus	Bus Route No	No. of Passengers in Bus	No. of seats in Bus	Level of Comfort
15	Merupu	1	45	39	1.15
16	Ordinary	3	50	34	1.48
17	Ordinary	3	44	37	1.19
18	Ordinary	3	39	37	1.05
19	Ordinary	3	49	37	1.32
20	Ordinary	3	49	37	1.32
21	Ordinary	3	52	34	1.53
22	Ordinary	3	61	34	1.79
23	Ordinary	3	51	34	1.5
24	Ordinary	3	34	34	1
25	Ordinary	3	48	34	1.41
26	Ordinary	3	26	34	0.77
27	Ordinary	11	32	34	0.94
28	Ordinary	11	42	34	1.24
29	Ordinary	11	35	34	1.03
30	Ordinary	11	45	34	1.32
31	Ordinary	11	32	34	0.94
32	Ordinary	11	24	34	0.71
33	Ordinary	11	36	34	1.06
34	Ordinary	11	46	45	1.02
35	Ordinary	11	54	45	1.2
36	Ordinary	11	48	37	1.3
37	Ordinary	11	34	37	0.92
38	Ordinary	11	55	37	1.47
39	Ordinary	11	72	37	1.95
40	Ordinary	11	38	41	0.93
41	Ordinary	11	41	41	1
42	Ordinary	11	37	41	0.9
43	Ordinary	11	41	34	1.2
44	Ordinary	11	55	34	1.61
45	Ordinary	11	34	34	1
46	Ordinary	11	42	34	1.23

The level of comfort was calculated by observing number of passengers travelling in the bus at any point of time in the journey. The ratio of average total number passengers in the bus to total seats in the bus gives average level of comfort. Average level of comfort is 1.14 which shows that buses are travelling with one person per seat. For conducting this survey, stop watches to accuracy of 1/10 of a second are used to note the delays and travel time. All the observers, equipped with stop watches, data sheet etc., travelled by a car. The speedometer of the vehicle was used to read off the distance covered. The test was run during peak hours along the major corridors in the city. All the data is presented in Table IV

Table IV

Journey speed of Private Vehicle from Kazipet to Warangal

S No	From	To	engtth of the route (km)	urney Tim(sec)	eed (km/hr)

S No	From	To	ength of the route (km)	urney Tim(sec)	eed (km/hr)
1	Kazipet	Fathima Jn	1.9	230	30
2	Fathima Jn	Subadari	2.3	224	37
3	Subadari	Adalath	1.2	102	42
4	Adalath	Petrol Pump	1.8	211	31
5	Petrol Pump	Hanmakonda	1.4	179	28
6	Hanmakonda	Mulugu Road	1.5	190	28
7	Mulugu Road	MGM	1.3	145	32
8	MGM	Pocham Maiden	1.2	167	26
9	Pocham Maiden	Laxmi Talkies	1.2	121	36
10	Laxmi Talkies	Warangal X Road	0.5	95	19
11	Warangal X Road	Warangal	0.8	193	15
12	Warangal	Warangal X Road	0.8	231	12
13	Warangal X Road	Laxmi Talkies	0.5	175	10
14	Laxmi Talkies	Pocham Maiden	1.2	131	33
15	Pocham Maiden	MGM	1.2	251	17
16	MGM	Mulugu Road	1.3	175	27
17	Mulugu Road	Hanmakonda	1.5	196	28
18	Hanmakonda	Petrol Pump	1.4	200	25
19	Petrol Pump	Adalath	1.8	310	21
20	Adalath	Subadari	1.2	176	25
21	Subadari	Fathima Jn	2.3	212	39
22	Fathima Jn	Kazipet	1.9	229	30

This survey was carried out as a part of Physical Inventory Study along the major Roads and arterials covering the entire study area. The Parking Spaces, the parking fare per vehicle data are collected individually for cars and two wheelers. The Parking Spaces Count was shown in Table V.

Table V
Parking Spaces Count

S.No	From	To	Length	parking		rking ECS
				car	2W	
1	Kazipet Jn	Flyover Starting	0.8	2	60	17
2	Flyover Starting	Flyover Ending	0.8	0	0	0
3	Flyover Ending	Fathima Jn	0.5	15	120	45
4	Fathima Jn	Nit Main Gate	0.8	5	15	9
5	Nit Main Gate	Rec Petrol Pump	0.3	3	55	17
6	Rec Petrol Pump	Subedhari	0.85	15	150	53
7	Subedhari	Collector Bungla	0.4	0	55	14
8	Collector Bungla	Adalath Jn	0.85	10	120	40
9	Adalath Jn	Tmc	0.35	3	65	19
10	Tmc	Ambedhkar Jn	1.1	20	255	84
11	Ambedhkar Jn	Ntr Statue	0.4	0	75	19
12	Ntr Statue	Govt.Hospital	0.6	2	54	16

S.No	From	To	Length	parking		rking ECS
				car	2W	
13	Govt. Hospital	Ashoka Jn	0.45	3	121	33
14	Ashoka Jn	Hnk Chowrastha	0.3	2	50	15
15	Hnk Chowrastha	Amrutha Jn	0.4	1	152	39
16	Amrutha Jn	Alankar Jn	0.55	40	253	103
17	Alankar Jn	Mulugu Jn	0.6	65	130	98
18	Mulugu Jn	Bsnl Office	0.5	1	125	32
19	Bsnl Office	Mgm	0.8	15	210	68
20	Mgm	pochamaidan	1.2	21	254	85
21	pochamaidan	Wngl Chowrastha	1.3	15	325	96
22	Wngl Chowrastha	Post Offfice Circle	0.35	2	125	33
23	Post Office Circle	Warangal Bus Stand	0.7	1	35	10

Major bus stops were chosen and timings of the bus and the passengers boarding the bus in that route were noted and tabulated as given below. The average waiting time of passengers is calculated from service frequencies of the bus routes w.r.t number of passengers boarding the bus. Average waiting times at each Bus Stop for different Bus routes are calculated as shown in Table VI. Average waiting Time of the passengers in that route = Arithmetic mean of waiting times for that route bus and Total No. of passengers boarding the bus route [17].

Table VI
Sample Calculation of Average Waiting Time

S No	Bus Route No	No. of Passengers boarding the bus in that route (a)	Waiting Time (min)(b)	Average Waiting Time of the Route (Σab/Σa)
1	1	16	2	15
2	1	11	20	
3	1	5	9	
4	3	14	17	
5	3	5	15	
6	3	8	14	
7	3	10	12	
8	3	4	16	
9	11	15	10	
10	11	5	12	
11	11	9	9	
12	11	12	15	

Land Use Data was collected from Warangal Municipal Corporation City Development Plan and Kakatiya Urban Development Authority. Google Maps were used to find out the developed area. Other miscellaneous data is also collected from the City Development Plan and are summarised in Table VII.

Table VII
Land Use Transport Data

Sector	Amount
Total Area in Hectares	11000
Total Developed Area in Hectares	7800
Total Population of the City 2014:	928570
Total Length of the Road Network	320 km

Sector	Amount
% of Non –Residential area along major transit Corridors	14%
Floor Space Index as per Master Plan / Development Plan	1
Floor Space Index along Major Transit Corridors	1.5
Intensity of Development along Major Transit Corridors	1.5
Road Network Pattern	Radial (Somewhat Clear Pattern)
Road Density	3.5
Street Lighting Coverage	80%
Volume to Capacity Ratio in the City	0.68

Accident Data was collected which was available at the latest. The required data is tabulated in Table VIII.

Table VIII

Accident data of Warangal City

Report	Number
Total No of Road Accidents in the city in 2013-2014	1206
Total No of Fatalities recorded as Road Accidents in the city in 2010	195
Total No. of Fatalities recorded of persons who were pedestrians	8
Total No. of Fatalities recorded of persons who were NMT users	9

VI. RESULT ANALYSIS

i. Presence of Organized Transport System in Urban Area

= Total number of buses owned by TSRTC/ Total Number of buses in the city

= (101*100) / 151 = 66.88%

ii. Extent of Supply Availability of Public Transport for 1000 population

= Total No. of buses available on any day / Total Population of the City

= (151*1000) /615998 = 0.25

iii. Service Coverage of Public Transport (Bus Route Network Density in km/sq.km) =

= Total Route length of Public Transport (km)/ Area of Urban limits (sq.km)

= 75/117 = 0.64 km/sqkm

iv. Average Level of Comfort in Public Buses

= Total No. of Passengers in the Bus/ Total seats in the bus

This is average value taken by travelling in buses along all routes in the city. Table 3 shows the level of comfort data and calculations in different routes. The average level of comfort in public buses in Warangal city is found to be 1.13

vi. % Fleet as per Urban Bus Specification

= Total No. of buses as per urban bus specifications/ total no. of buses

= (84*100)/151 = 55.62%

vii. Average Bus Stop Spacing: Bus Stop spacing can be measured from Google maps by taking distances between the successive bus stops and then finding out the average. = 650 mts

viii. Percentage of Commuters using Public Transport = 23%

ix. Percentage of Commuters using Autos = 15%

Integrated Land Use Transportation

i. Population Density = Total Population of the City/ Total Developed Area in hectares
= 615998/ 6818 = **90.34**
ii. Proportion of Non-Residential Area along major Transit Corridors = 14**%**

iii. Intensity of Development Citywide= F.S.I as per Master Plan applicable to most part of the city. = **1.00**

iv. Intensity of Development along major Corridors = F.S.I along Major Corridors/ F.S.I as per Master Plan applicable to most part of the city
= 1.5/ 1.00 =**1.5**
v. Road Network Pattern and Completeness
Warangal is said to have a **Radial** pattern as per Master Plan. Somewhat clear network is observed during study.
vi. Percentage of Area under Roads = Total area under Roads/ Developed area of City = **13%**

vii. Percentage of Road Network having Exclusive ROW for Transit Network = **0%**

Road Safety
i. Fatality Rate for Lakh Population= (195*1, 00,000) / 6, 15,998 =**32person**
ii. Fatality Rate for Pedestrians and NMT users= (9+8)*100/195 =8.71**%**
iii. Accident Rate (Present/ Past) = 1206/808 =1.49

VII CONCLUSIONS

Traffic management is not a guaranteed cure for traffic congestion. It needs constant adjustment and enforcement to be effective Where it does not involve any major engineering (as for instance with bus or non-motorized transport priorities), the program can fall away quickly. The commitment of the police to maintain enforcement of measures is particularly critical. Improving transport system operations and management can help to clear bottlenecks and reduce congestion. Prior to making costly investments in new transport infrastructure, options for better utilizing and managing existing system capacity for motorways, public transport systems and freight logistics should be explored. This corridor management study has carried out for the Warangal city using the concept of service level benchmarks. The Public Transport system in Warangal is in a better condition in terms of service coverage and number of buses in the city. Vehicle Headways are observed to be a bit high than normal as the waiting time of the passengers is between 16 to 20 minutes. All the arterials in the city are not covered with footpaths. The travel speeds of motorized vehicles are observed to be around 30 kmph and that of public transport is around 20 kmph which needs attention. Pollution Levels of the city are under control. Non-Motorized transportation facilities are to be improved. Foot Paths are need to improve and maintained. It is observed that Bus stops are not in proper condition. This corridor management study has carried out for the Warangal city using the concept of service level benchmarks.

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