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Transportation Research Procedia 00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

Urban Corridor Management Under Heterogeneous Traffic Conditions

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Abstract

Road traffic has been experiencing rapid growth nowadays due to combined effect of population growth; increase in ownership of vehicles and mobility of individuals which results in delays, congestion, accidents etc. The improvements of existing facilities have failed to keep pace with the growth of motor-vehicle traffic. In order to reduce all these problems corridor management is necessary. The ultimate aim of any corridor management study is to improve the mobility of the corridor within the available facilities using strategies of corridor management. This study mainly deals with evaluating the efficiency of corridor between Habsiguda to Sangeeth Junction (Secunderabad) whose length is 5km with 3 signalized intersections and 4 mid-blocks by evaluating speed, volume, journey time, delay, Level of Service (LOS) and suggests management measures by causality analysis. These parameters are known by conducting volume studies, speed studies by using GPS and moving car method. Performance evaluation includes peak hour identification, delay at mid blocks, LOS at mid blocks followed by the identification of bottle necks by plotting speed contours and suggesting management measures keeping in mind that those have to be of low-cost solution, easily executable, effective and road user friendly. From our study, we have inferred that variation in volume along the corridor is observed in our study, with highest peak hour volume occurring in Sangeeth junction. Comparison of speed profiles in peak and off-peak hours has been done. We have further inferred that Tarnaka-Habsiguda segment has been experiencing least LOS and more bottlenecks compared to other segments.

Keywords: Corridor Management; Level of Service (LOS); Congestion; Speed Contours.

1. Introduction

The rapid growth of India's urban population has generated demand to provide better transport facilities and

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services to public. The main challenges to be faced are to provide these services through the congested, dense urban areas. Air pollution, Noise, Congestion and accidents are much more severe in India than those in other countries. All the vehicles Indian cities are mainly disadvantaged by congestion conditions. Buses are travelling in an extremely congested, narrow street, with no separate rights-of-ways and have to fight in heterogeneous traffic conditions. The root cause of congestion is the failure of individual drivers to consider the external cost of their behavior. Congestion leads to increase in travel costs. Especially in India, these congested conditions in public transport vehicles, stations, and rights-of-way not only slow down travel but make it outright dangerous. Tens of thousands of public transport passengers are killed or injured every year in accidents. This also leads to the problem of safety. To address the urban transport challenges faced in India, corridor management techniques can be applied on the urban corridor. The ultimate aim of any corridor management study is to improve the mobility of the corridor within the available facilities using the corridor management strategies. In this policy, the performance of the study corridor is evaluated and the best management strategies are suggested which addresses the current problem.

In a study conducted by (Piyush et al., 2005) at Kampala the capital of Uganda and the hub of political, economic, commercial, Government services and transport activities in Uganda. Located at the Northern shores of Lake Victoria, Kampala's population has been experiencing rapid growth from 3,30,700(1969) to 7,75,000 (1997), projected to reach about 1.6 million by the year 2006. He explained various measures to be taken for growing traffic conditions. A case study of Ameerpet –kukatpally corridor" has been studied the entire corridor using various factors such as volume, delay, LOS and suggested various management measures to be followed (Jasti pradeep Chaitanya, 2009) and he also studied a unique Way to Represent the mobility of an urban road network by speed contours and explained how speed contours can help in determining bottlenecks and weaker portions in every segment in a corridor.

According to the world bank (2005) Report examined measures to improve management of transport corridors by measuring quality in terms of transit time, cost of shipment of goods along the corridor and reliability of services in terms of flexibility provided in terms of diversity of services offered on multi-modal routes and transit time. A Study Conducted in Indian Cities by (Azeemuddin, 2009) has explained the growth of Indian economy and impact of growth on Indian traffic and strategies to mitigate congestion such as better transportation systems, carpooling, and intelligent transportation system (ITS). The Highway capacity manual (HCM, 2010) explains various concepts, methodologies, corridor wise analysis, simulation models to be used for different types of roads. LOS determination studies. And also, British Columbia Ministry of Transportation, (2004) has proposed specifications on the strategies of management in their country to maintain the corridors in winter to make 100% route availability to make their roads safer. The main areas that are taken care are safety, lighting, signage, electrical system, access control, line marking and vegetation control.

Various corridor management measures, concepts, methodologies have been explained by authors effectively. This study is a congregation of all the important aspects explained by the aforementioned authors. Speed contours methodology is well appreciated in this study as not much research is done on this aspect and there is tremendous scope for further work.

2. Study Area and Methodology

The Study area comprises of major public transport corridors starting from HABSIGUDA Junction to SANGEETH junction. It traverses along important city arterial road network and being the main transit route in the city from east to west. The land use along the corridor is predominantly residential and commercial. All this contributes to significant travel demand.

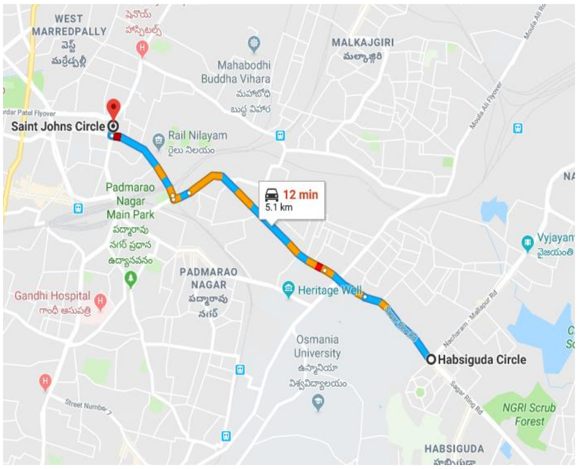


Fig. 1 Map showing the study area.

The brief physical layout of the corridor taken up for the study and the summary of road inventory is shown in the table below.

Table 1. Physical inventory of the corridor

Segment Name & No.	Width of the pavement (m)				Length(m)
	Maximum	Minimum	Average	Shoulder	
Habsiguda to Tarnaka	14	10.5	12.25	1.5	1400
Tarnaka to Mettuguda	14	09	11.5	2.0	1700
Mettuguda to Alugaddabavi	14	07	10.5	1.0	750
Alugaddabavi to Sangeeth	14	07	10.5	1.0	1100

2.1. Methodology

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

(a) Identification of Study area:

This is the first stage of the project. There is a need to identify the study area where the corridor management studies are to be carried out. Hyderabad city is selected as the study area.

(b) Physical inventory of the Corridor:

At first, the major key corridors, arterials and sub arterials are to be identified in the study area. A brief map layout of the city is to be obtained. This gives a brief physical layout of the corridors taken up for study.

(c) Traffic Data Collection:

The data collection is the primary one. Various studies are to be conducted to measure the traffic flow, journey time and to understand the behavior of the corridor.

(d) Estimation of traffic volume:

Traffic volume studies are collected along the selected corridor using manual method of study. It involves manual counting of the vehicles at various selected mid-blocks and intersections. Video recorded data was used to measure traffic volume. CCTV footages at required locations were collected from the police commissionerate.

At mid-blocks, a line across the road was selected as observation line. The various classes of vehicles crossing the observation line were counted separately for 2hrs in the evening peaks. The through and right turn traffic is counted from the video data for a period of 2hrs.

(e) Estimation of journey time and delay:

Among different methods of speed and delay studies, Floating car method was used to determine the average journey time and average delay along the corridor.

In this, test vehicle is driven along the corridor at an average speed of the stream. One observer records the time of arrival of test car at various control points which are to be fixed before, and the duration of each delay using stop watch. Second observer notes the number of vehicles overtaking the test vehicle and overtaken by the test vehicle. The number of vehicles travelling in the opposite direction is noted by another observer. The average journey time $\bar{t}$, in minutes for all vehicles in a traffic stream in the direction of flow is given by

$$\bar{t} = t_w - n_y/q \quad (1)$$

$$q = \frac{n_a + n_y}{t_a + t_w} \quad (2)$$

(f) Estimation of LOS at mid-blocks:

Highway capacity manual, HCM 2000 is used for determination of LOS in segments of corridor. LOS can be determined directly on the basis of free flow speed (FFS), journey time. FFS is determined using the test car with GPS to run at low volumes. Class of urban street can be determined from FFS. Speeds are to be recorded for each segment when the vehicle is not impeded by vehicles. Running time and delays for each segment is calculated using moving car method. Average travel speed can be determined using the Equation. 3

$$S = \frac{3600 \times L}{T_R + d} \quad (3)$$

Where, L =length of the segment in Km

T_R= total running time in defined section

d= delay for through movements between center points of intersection

Table 2. LOS determination from average travel speed

Urban Street Class	I	II	III	IV
Range of free flow Speed (FFS)	90 to 70	70 to 55	55 to 50	50 to 40
Typical FFS	80 kmph	65kmph	55kmph	45kmph
LOS	Average travel Speed (km/h)			
A	>72	>59	>50	>41
B	>56-72	>46-59	>39-50	>32-41
C	>40-56	>33-46	>28-39	>23-32
D	>32-40	>26-33	>22-28	>18-23
E	>26-32	>21-26	>17-22	>14-18
F	≤26	≤21	≤17	≤14

(g) Drawing Speed Contours:

A Speed contour is similar to a topographic contour in which the ground levels were substituted with speed and the easting, northing were substituted with distance and time respectively resulting in a contour plot. For this, speeds were recorded during the peak hours throughout the road network by travelling by a car with a GPS fitted. Speeds were recorded for every 200m interval by using the GPS. Speeds for all segments in to and for directions, distance and time required to travel in each segment are added as inputs for contour plot using MINITAB16 software. After plotting the multicolored speed contours, it can be analyzed since the weaker and healthier portions of the corridor are represented with dark and light colors respectively

2.2. Moving car method

For conducting this survey, a test car with four observers and 2 stopwatches along with data sheets has been used to note the delays and travel time and required readings.

The test car was run during peak hours along the major corridors in the city. All the data is presented in following tables:

Table 3. Data of speed and delay studies by floating car method

Trip no.	From-To	Journey time (sec)	Total stopped delay (sec)	No.of vehicles overtaking	No.of vehicles overtaken	No.of vehicles from opposite direction
1	Habsiguda-Sangeeth	607.2	142.4	77	43	1252
2	Sangeeth-Habsiguda	631.6	104.1	50	67	1248
3	Habsiguda-Sangeeth	616.9	51.6	79	23	1314
4	Sangeeth-Habsiguda	650.9	68.7	94	46	1251
5	Habsiguda-Sangeeth	609.1	21.3	69	95	1900
6	Sangeeth-Habsiguda	837.8	224.08	33	82	1452
7	Habsiguda-Sangeeth	549.3	123.3	42	89	1450
8	Sangeeth-Habsiguda	910.1	72.2	153	134	1537

Table 4. Mean values of speed and delay data:

Trip no.	From –To	Journey time, (sec)	Total stopped delay, (sec)	No. of vehicles overtaking	No. of vehicles overtaken	No. of vehicles from opposite direction
1	Habsiguda-Sangeeth	607.2	142.4	77	43	1252
		616.9	51.6	79	23	1314
		609.1	21.3	69	95	1900
		549.3	123.3	42	89	1450
	Total	2382.5	338.6	267	250	5916
	Mean	595.625	84.65	66.75	62.5	1479
2	Sangeetha-Habsiguda	631.6	104.1	50	67	1248
		650.9	68.7	94	46	1251
		837.8	224.08	33	82	1452
		910.1	72.2	153	134	1537
	Total	3030.4	469.08	330	329	5488
	Mean	757.6	117.27	82.5	82.25	1372

2.3. Speed Studies

The speed calculated by GPS along the corridor for every 200m is as shown in the fig. 2

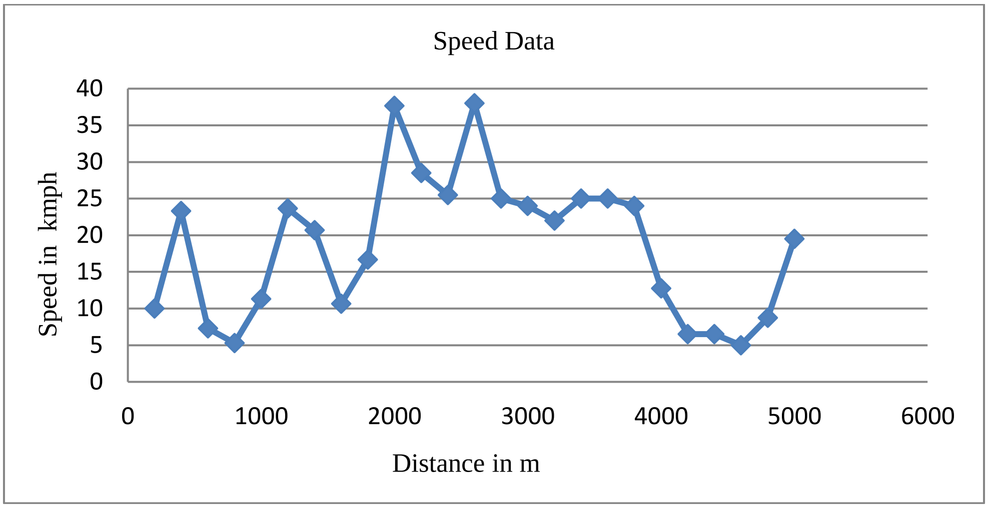


Fig. 2 Speed data along the corridor

3. Data Analysis

The data collected is to be processed and to be analyzed to know the problems within the corridor. Analysis of the data included the following:

- Variation in traffic volumes along the corridor is analyzed.
- Estimation of average journey time and travel time
- Bottleneck analysis by plotting speed contours
- LOS estimation for mid-blocks.

3.1 Variation in Volume along the Corridor

The peak hour volumes and its variation were as shown in the figure. Where intersections are considered, Sangeeth junction recorded highest peak hour volume and where segments are considered Habsiguda-Tarnaka recorded the highest peak hour volume.

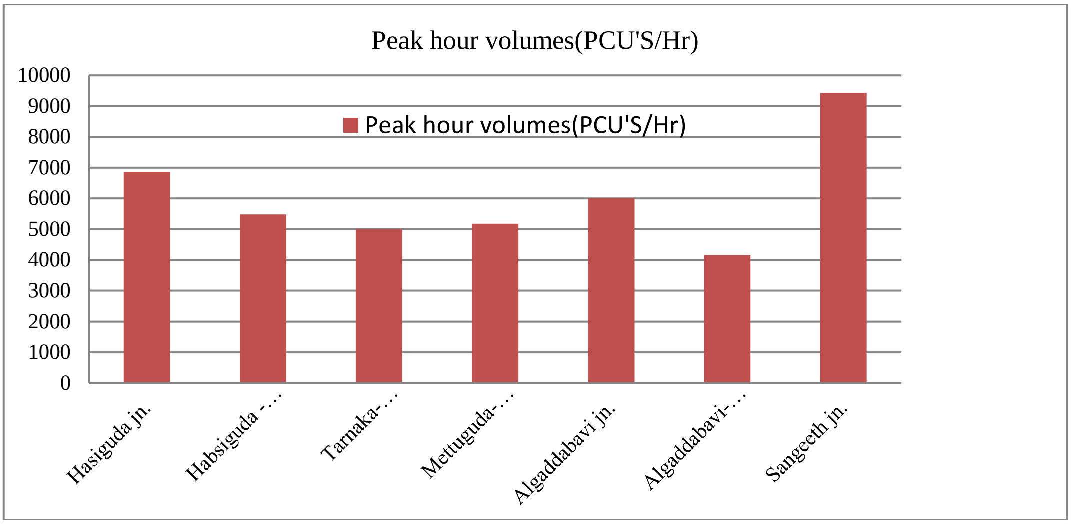


Fig. 3 Variation of Volume counts along the corridor

3.2 *Variation of Volumes along each Segment with Time*

The figures are drawn showing the variation of volume for every 15 minutes for a total duration of 2hrs. These graphs show the variation of volume with time and can be used to plan traffic operations and control of existing facilities. These graphs can be used for proper planning of signaled intersections.

It can be seen from the below figures that volume of traffic is increasing as we go from 5:00 to 7:00.

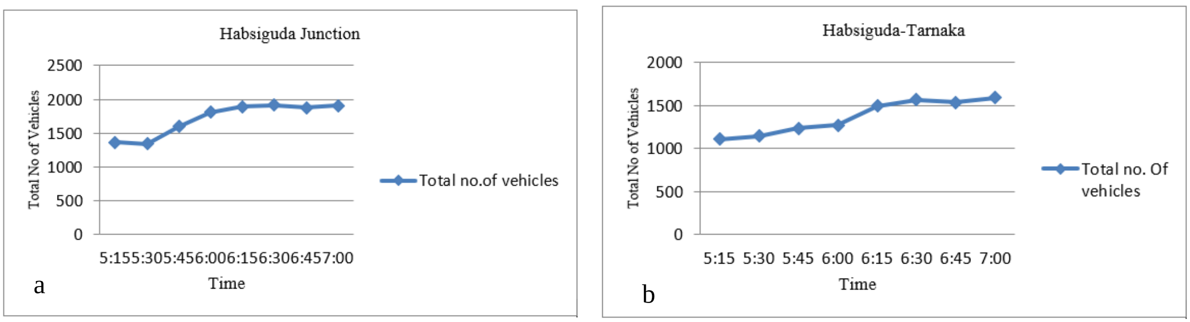


Fig. 4 (a) Variation of volume with time in Habsiguda junction (b) Variation of volume with time in Habsiguda-Tarnaka junction

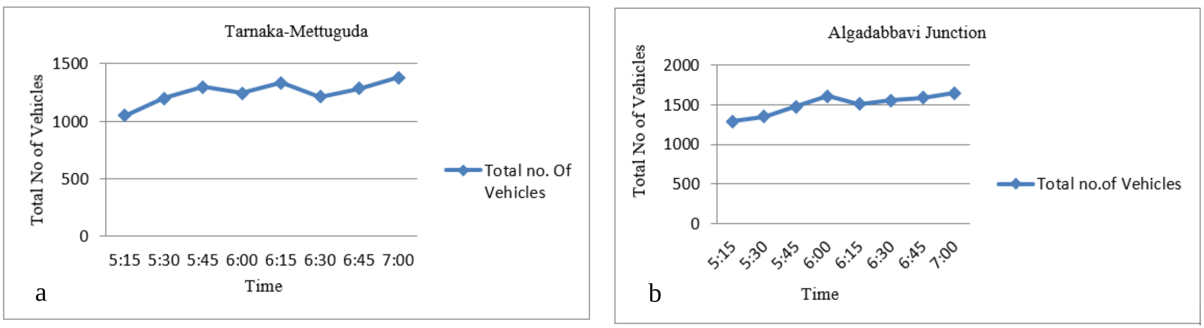
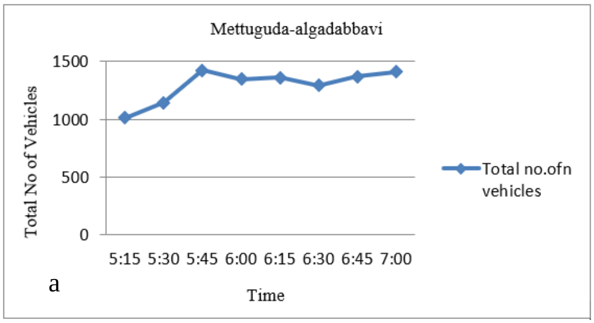


Fig. 5 (a) Variation of volume with time in Tarnaka-Mettuguda junction (b) Variation of volume with time in Alugaddabavi junction



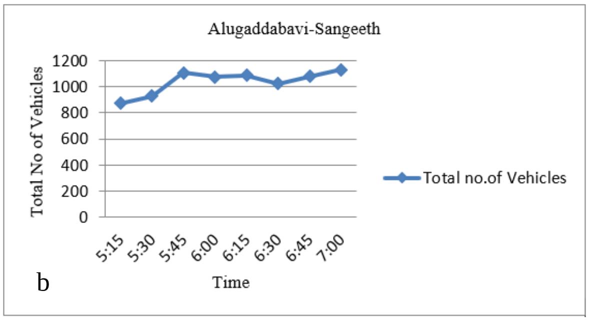


Fig. 6 (a)Variation of volume with time in Mettugda-Alugaddabavi junction (b)Variation of volume with time in Alugaddabavi-Sangeeth junction

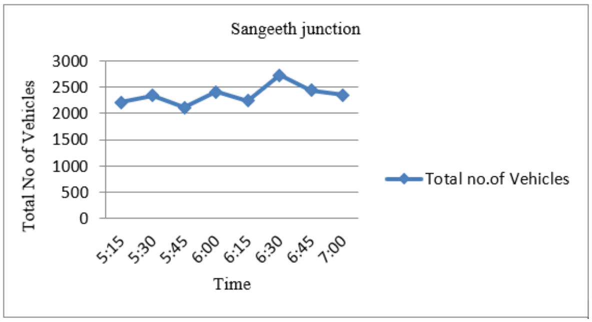


Fig. 7 Variation of volume with time in SANGEETH junction

3.3 Analysis of Moving Car Method

These studies are useful to identify the delays at mid blocks whose results are presented below:

Table 5. Results of Floating Car Method (H-S)

Habsiguda-Sangeeth	
Elements	Peak Time
Avg. Journey Time (min)	9.86
Avg. Running Time (min)	8.45
Avg. Journey Speed (kmph)	30.43
Avg. Running Speed (kmph)	35.5
Avg. Delay (min)	1.41

Table 6. Results of Floating Car Method (S-H)

Sangeeth-Habsiguda	
Elements	Peak Time
Avg. Journey Time (min)	12.62
Avg. Running Time (min)	4.8
Avg. Journey Speed (kmph)	23.77
Avg. Running Speed (kmph)	62.5
Avg. Delay (min)	7.82

3.4 Plotting 0f Speed Contours

Contours plotted by MINITAB can be easily judged by eye vision. The values of time, distance and speeds are simplified for inputs in MINITAB 16 and represented on X, Y and Z axes respectively to plot a multi colored speed contours as shown in the figure.

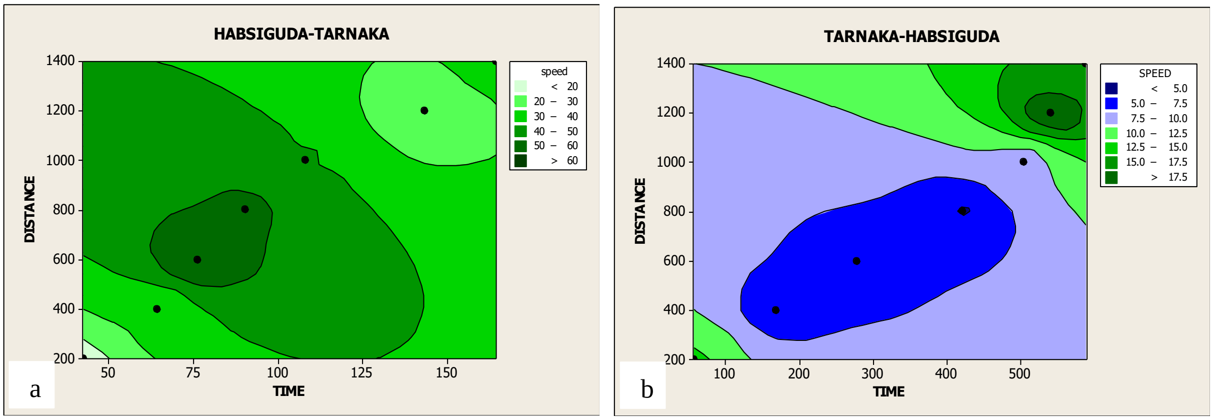


Fig. 8(a) Speed contour of Habsiguda-Tarnaka corridor (b) Speed contour of Tarnaka-Habsiguda corridor

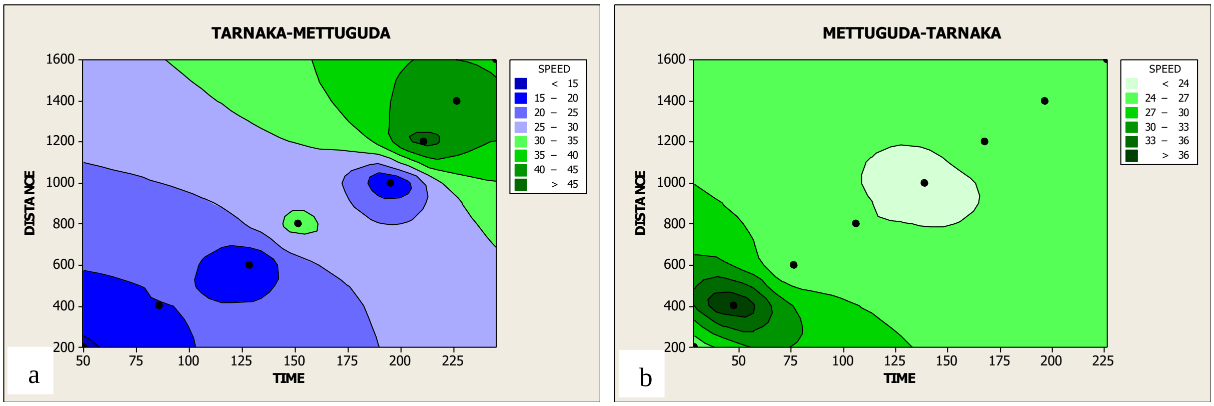


Fig. 9 (a) Speed contour of Tarnaka-Mettuguda corridor (b) Speed contour of Mettuguda-Tarnaka corridor

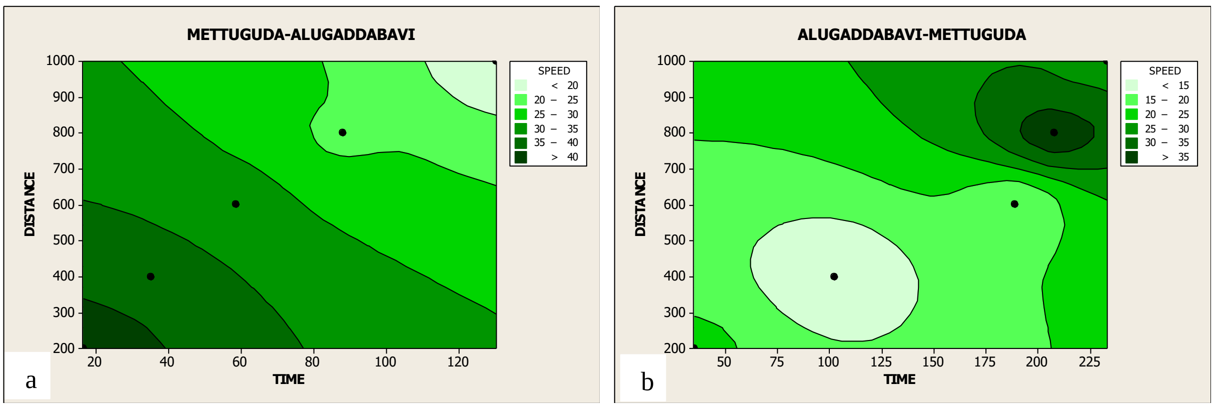


Fig. 10 (a) Speed contour of Mettuguda-Alugaddabavi corridor (b) Speed contour of Alugaddabavi-Mettuguda corridor

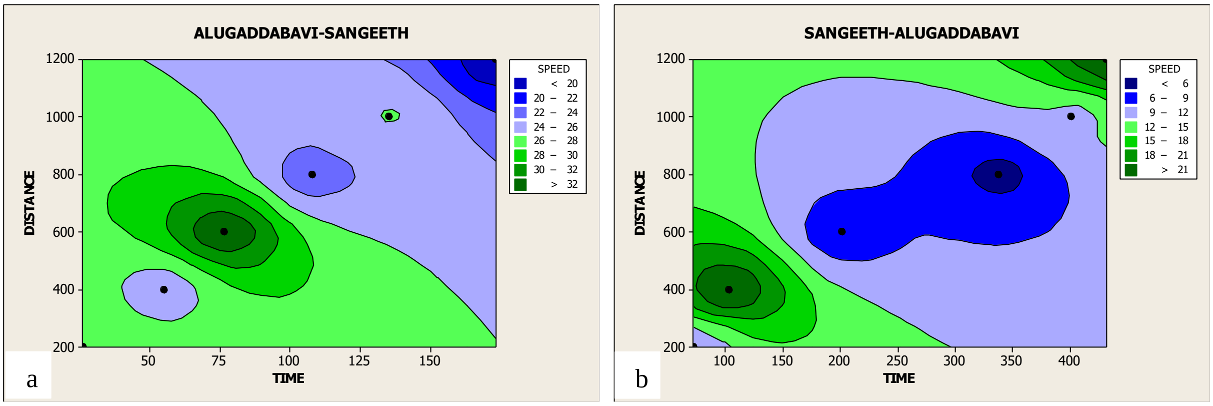


Fig. 11 (a) Speed contour of Alugaddabavi-Sangeeth corridor (b) Fig. 5.16 Speed contour of Sangeeth-Alugaddabavi corridor

3.5 Identifying weaker portions and bottle necks using speed contours

Once a multi colored speed contour is plotted using the speed data it's an easy job to identify the bottle necks and faulty location along the corridor. But we need to carefully assign the speed intervals for plotting the speed contours. For the present study the speeds were classified into various groups between <10kmph to >60kmph with a unique color for each speed group as shown in the legend in the figures. One can easily identify the weaker and healthy areas of a corridor. Weaker areas are the areas where the speeds are less than 20kmph and sections with speed less than 10kmph are identified as bottlenecks. Every 200m of the corridor is taken as individual segment. The weaker portions and bottlenecks in the SANGEETH-HABSIGUDA corridor is as shown in the table.

Table 7. Identification of weaker portions and bottle necks

Corridor	Direction	L(km)	Weaker positions		Bottle necks	
			Existence(no)	Severity(m)	Segments(no)	Severity(m)
Habsiguda-Tarnaka	Up	1.4	nil	0	nil	0
	Down		2	400	3	600
Tarnaka-Mettuguda	Up	1.7	2	400	2	400
	Down		2	400	nil	0
Mettuguda-Alugaddabavi	Up	0.75	1	200	nil	0
	Down		2	400	2	200
Alugaddabavi-Sangeeth	Up	1.1	1	200	nil	0
	Down		3	600	1	200

3.6 Los Estimation at Mid-Blocks

Measurement of travel speed of Sangeeth-Alugaddabavi

From Equation 3, Average travel speed $S=\frac{3600\times L}{T_R+d}$

$$S=\frac{3600\times 1.1}{152.675}=25.94\text{kmph}$$

FFS recorded for Sangeeth-Alugaddabavi segment is 70kmph.

According to table, for the travel speed of 25.94 kmph LOS is D

Table 8. LOS determination of Sangeeth-Habsiguda

Segment	FFS (kmph)	Urban street class	Average travel speed	LOS
Sangeeth-Alugaddabavi	70	II	25.94	D
Alugaddabavi-Mettuguda	65	II	26.71	D
Mettuguda-Tarnaka	65	II	33.51	C
Tarnaka-Habsiguda	75	I	15.68	F

Table 9. LOS determination of Habsiguda to Sangeeth

Segment	FFS (kmph)	Urban street class	Average travel speed	LOS
Habsiguda-Tarnaka	70	I	23.85	E
Tarnaka-Mettuguda	65	II	32.18	D
Mettuguda-Alugaddabavi	65	II	28.76	D
Alugaddabavi-Sangeeth	75	II	28.38	D

3.7 Comparison of Speed Profiles

The comparison between speed profiles of peak and off-peak hours are as shown in the figure 10 (a).

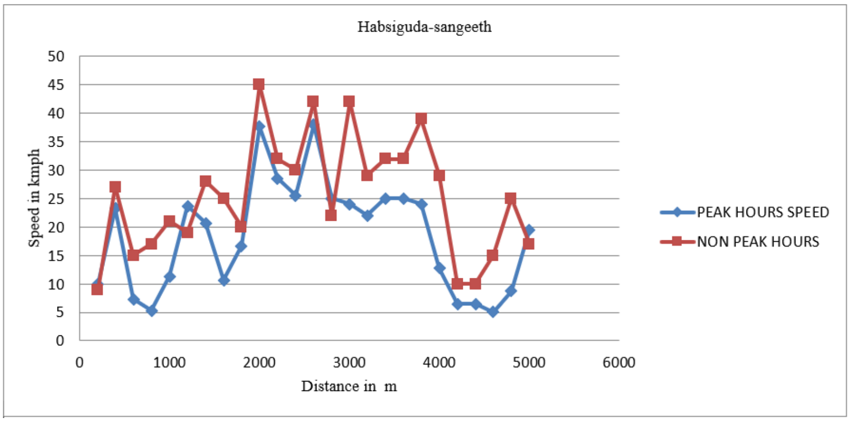


Fig. 12 Comparison of speed profile in peak and off-peak hours

4. Summary and Conclusions

4.1. Summary

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, 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 been carried out for the Hyderabad city using the concept of Level of Service.

The following traffic studies have been carried out to evaluate the performance of the corridor.

- Volume Studies
- Travel speed along major corridors
- Journey time and delau
- Level of Service

The average delay caused to vehicles is an important and commonly used measure to evaluate the segment performance. The vehicular composition, away from traffic volume is vital factor influencing the extent of delay caused to vehicles. As field measurement of delay caused to vehicles is tedious and difficult, theoretical models are generally used to estimate the delay.

The Level of Service and Speed contours were developed to understand the deficiencies in the corridor. This can be a effective technique to manage a corridor as the surveys required, data requirements are fixed and no biased judgment of level of service calculations are possible. Based on these results and causality analysis done during the survey to identify the problems and their root cause, the low-cost management measures have been suggested in order to improve their performance.

4.2. Conclusions

- The peak hour volume is high for Sangeeth junction. Similarly, Habsiguda-Tarnaka segment in midblocks has high peak hour volume.
- Delay is high at Habsiguda intersection and less at Alugaddabavi intersection.
- Delays in the mid blocks are noticeably high in Habsiguda to tarnaka segment and low in Tarnaka to Mettuguda segment.
- Total eight bottlenecks were identified.
- Tarnaka-Habsiguda corridor is performing low in the mobility aspect of entire corridor. It is having highest number of bottle necks and weaker portions.
- Mettuguda-Alugaddabavi segment is performing relatively good compared to other segments.
- Speed contours are a low-cost procedure to understand the system's performance within a short period of time and with less man power of 2-3.
- The technique for speed contours for the evaluation of urban transportation network's mobility is representing the real-world picture completely, hence it can be followed to evaluate and understand the same.
- The encroachments are severe problem because of their adverse impact on capacity.
- When the overall corridor's performance is considered, the corridor is performing up to satisfactory level in the present conditions but questionable for the future traffic conditions. It can be improved when the pedestrian crossings are made easier for which the management measures have already been suggested.
- Improving the corridors performance is not only in the hands of transportation professionals and the governing bodies, but the major contribution has to come from the road users that they need to obey the traffic rules and switch to public transport instead of travelling alone in a car.
- Speed comparison between peak and off-peak hours is observed along the corridor.

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