Black Spot Analysis Using QGIS for S.P. Ring Road, Ahmedabad (Ch.: 00.00 Km to Ch.: 76.30 Km)

Parth B. Parmar[1], A. A. Amin [2], Dr. L. B. Zala [3]

[1]Student of Final Year, M. Tech (Transportation System Engineering), B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India,

[2] Assistant Professor, Civil Engineering Dept., B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India,

[3] Professor and Head, Civil Engineering Dept., B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India,

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Abstract - *Road Accident is a vital issue which is occurring all over the world. Accident severity is increasing with exponential increase of vehicle population. Accident leads to disablement, damage to health and property, social suffering, general degradation of environment and in extreme case, death. In this paper, efforts have been made to recognize the locations of accident black spots on Sardar Patel Ring Road, Ahmedabad. The western part of Ahmedabad has settled mainly as a residential area and the eastern part has industrial estates. A 76.3 km road was planned around the developing areas of Ahmedabad to strengthen the existing road network within the city. Thus, the problem of traffic congestion and occurrence of road accidents are frequent on the Ring Road. Road crash data collection has been done from various police stations of Ahmedabad district. The road inventory survey, traffic volume count survey and spot speed survey are done on the study area stretch. Mapping and geospatial analysis has been done in freely available Quantum GIS (QGIS) software. This paper also discusses some suggestions which can be implemented on that particular corridor which has been identified as stretch with maximum accidents. This study will showcase how to carry out black spot identification for urban areas of developing countries using open source GIS software. The conclusion suggests the remedial measures as per the observations.*

Key Words: **Accidents, Black spot, Geographic information system, Heat map, Quantum GIS**

1. INTRODUCTION

India is a developing country. Accident severity is increasing in increasing order due to increasing in vehicle population. Accident leads to disablement, death, damage to health and property, social suffering and general degradation of environment. The main cause of accidents is the driver, vehicle and road environment. Generally accidents occur at intersection where low volume traffic mixes with high speed traffic. Economic growth leads any nation to develop its Infrastructure and basic amenities. Road infrastructure falls under it. Hence, National highway is backbone of our Road infrastructure. India is having second largest road network after United States (67,22,347km) in world of approximately 54,72,144 km (as per 2017).It also leads to rapid urbanization, Industrialization, rapid motorization, social activities etc. Thus with the rapid Motorization increases the Road traffic crashes also increases.

The figures for the people killed in the road accidents in India came down by 4,560 (3%) in 2017 from 1.50 lakh the previous year of 2016, as per the Supreme Court committee on Road safety. Whereas, Punjab, Gujarat and West Bengal have shown a decline, UP, Bihar, MP and Odisha have reported more deaths. Growth in the number of persons killed in road accidents during 2017 at 1, 46,377 were lower by 3% as compared to 2016 level. Gujarat is also facing serious threat in road accidents. In response, the Gujarat government is trying to cut the fatality rate by half through a new road safety policy that focuses on first response at the 'golden hour' (the first hour after the accident). The state government wants to reduce the fatal accident by nearly 50% by 2020. To reach this goal identification of black spots is the first step. This paper is a step forward in the procedure of identification and analysis of black spots using GIS. QGIS 2.18.3 is used for the identification and analysis using heat map plugin and information query tool respectively.

2 LITERATURE REVIEW

Harsh Naik et. al.(2016) had made an efforts to identify the location of accident black spots on Sarkhej-Gandhinagar Highway (NH 147). S.G.Highway is the connection link between the business hub of Gujarat, Ahmedabad and the capital city, Gandhinagar. It faces huge traffic demands on daily routine. To carry out Black Spot analysis, IRS P-6 LISS-III data has been used. Mapping and geospatial analysis is done in freely available Quantum GIS (QGIS) software. Primary and secondary data of January 2013 to August 2015 are collected for the study and analyzed.

Deepthi Jayan K. et al. (2010) have identified high rate accident location or safety deficient areas within Kannur district, Kerala during the year 2006, 2007 and 2008. They have applied "Density" function (simple and kernel) of ArcGIS software to analyze spatial data and identified accident patterns. These results are then sent to 'expert' systems for providing suitable recommendations.

Dr. S. S. Jain et. al. (2011) found that trucks are parked on highway which reduces the effective width of carriageway and creating traffic hazards to high speed moving traffics. Unauthorized median openings were found which should be immediately closed. Missing road and median markings to be done and speed signs should match with speed. Access and service lanes are also deficient which requires immediate

improvement. The most Vulnerable Road User (VRU) i.e. pedestrians and cyclists facilities near habitation are lacking and needs to be facilitated on priority.

Dr. Wen Long YUE et al. (2001) provides all the information related to various tools and function for accident studies in GIS. GIS is suitable for spatial data analysis, graphic display, visual interface, etc. These features have important applications for traffic safety problems identification. The paper presents the process including formation of black spot and how these black spots are then analyzed in GIS using information query tool for night time accidents, peak hour accidents, accidents involving pedestrian, etc.

Liyamo lIsen et al (2013) has identified the most vulnerable stretches in the two districts Alappuzha and Ernakulam of the state Kerala. They have used Weighted Severity Index (WSI) method to rank the accidents, from which top six and ten spots were selected as black spots in Alappuzha and Ernakulam respectively. These black spots were then analyzed using prioritization method in ArcGIS. Two stretches were identified as the most vulnerable accident locations and suitable remedial measures were provided for these locations.

3. OBJECTIVES OF THE STUDY

1. Define Accident prone location on selected stretch of S.P. ring road.

2. Suggest remedial measures for the black spot.

4. STUDY AREA PROFILE

SP Ring Road is of strategic importance to the city as it integrates land use planning with road network and other infrastructure facilities. It is essential for improving the functional efficiency and steady growth of urban and metropolitan areas of Ahmedabad city. The western part of Ahmedabad has developed mainly as a residential area and the eastern part has industrial estates. Because of this, there is heavy traffic flow from west to east in the mornings and vice-versa in the evening. This causes serious traffic congestion and frequent traffic jams on the city roads during peak hours, besides air pollution. Traffic volumes on major roads have been studied and it has been observed that traffic volumes exceed the carrying capacities at many places. According to projections, an additional population projected for the Ahmedabad urban complex area for the year 2011, generated substantial additional traffic volumes. There was thus a felt need to plan road network so as to accommodate the future growth in traffic. The road network in Ahmedabad consists of rings and radials. A 76.3 km road was planned around the developing areas of Ahmedabad to strengthen the existing road network within the city. Conceived as the outer most 'ring' encircling Ahmedabad urban agglomeration, the ring road encompasses an area of about 400 sq. km which includes most of the developed and developing areas and covers a population of 40 lakhs. The

entire length of this road is 76.313 km. radiating from the city, there are 19 major roads of various categories either connecting or crossing this road. Ribbon development can be seen around the S.P.ring road. The stretch is busy with more number of vehicles and over the years traffic density has gone up.

Fig -1: Study area location

4. DATA COLLECTION

Data collection is one of the most important tasks as it is essential to get the road accidents information. Data collection for this study consists of both primary and secondary sources. Primary data is to be collected by performing various surveys on S.P. Ring Road and the secondary data is to be collected from various police stations of Ahmedabad city and Ahmedabad Rural areas.

4.1 Field Surveys

Extensive amount of a survey work is required to ascertain the road network characteristics of the selected stretch. Road inventory survey was carried out to find the existing land use adjacent to the selected stretch. The following primary surveys were carried out for achieving the objectives:-

1. Road inventory survey

2. Road crash data from police stations

3. Traffic volume count

4. Speed measurement survey

Following table shows the total number of accidents by its severity which were collected from the total 9 police stations.

4.1.1 Road crash data from police stations

Accident data was collected from various police stations along the study area stretch on the Sardar Patel Ring Road. The data were recorded in the crime register book in several police stations whereas digital format available in several city area police stations from year 2012-2017.

Table -1: Accident data collected from police stations

POLICE ST. NAME	Fatal	Serious	Minor	Damage only	Total
CHANGODAR	9	9	2		20
NARODA	16	39	27	3	85
ODHAV	20	25	41	1	87
RAMOL	34	11	33	2	80
VIVEKANAND NAGAR	8	2	10	2	22
ASLALI	17	16	20	1	54
ADALAJ	17	20	30	1	68
SARKHEJ	13	10	13	2	38
BOPAL	3	12	13		28
total	137	144	189	12	482

4.1.2 Composition of Vehicle

To understand the heterogeneous traffic characteristic on SP ring road, traffic volume count by manual method was carried out at selected points of ring road are as follows:-

1. Agora mall
2. Vaishnodevi circle
3. Shantipura circle
4. Sanathal circle
5. Hathijan circle
6. Palm hotel (odhav)
7. Dehgam circle

The total hourly vehicle compositions for above mentioned locations are shown in below charts.

Fig -2: Hourly vehicle composition at Agora mall

Fig -3: Hourly vehicle composition at Vaishnodevi circle

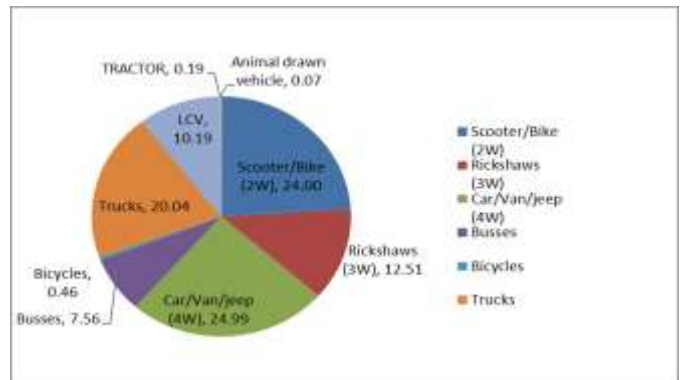**Fig -4**: Hourly vehicle composition at Shantipura circle

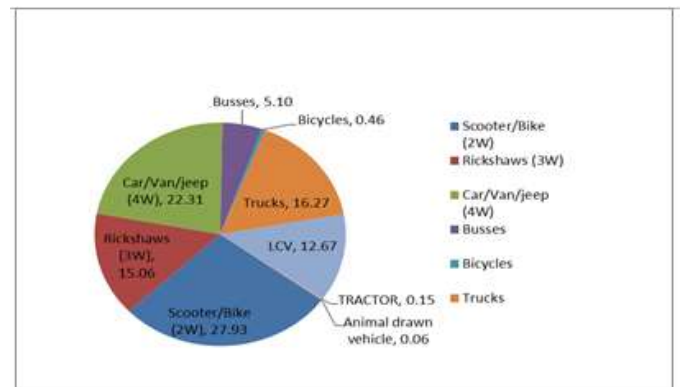**Fig -5**: Hourly vehicle composition at Sanathal circle

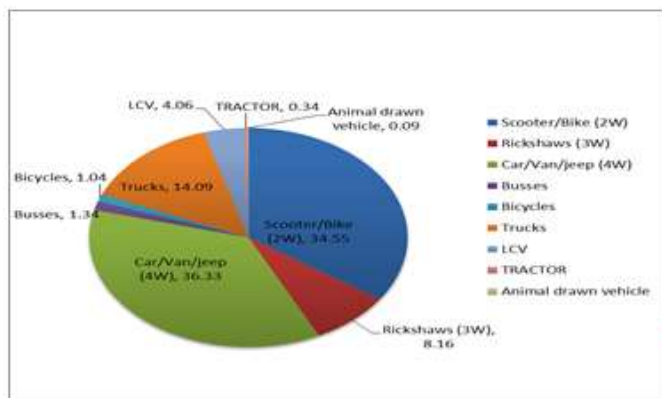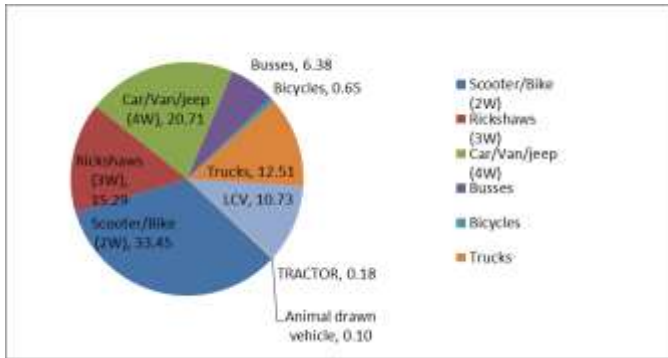**Fig -6**: Hourly vehicle composition at Hathijan circle

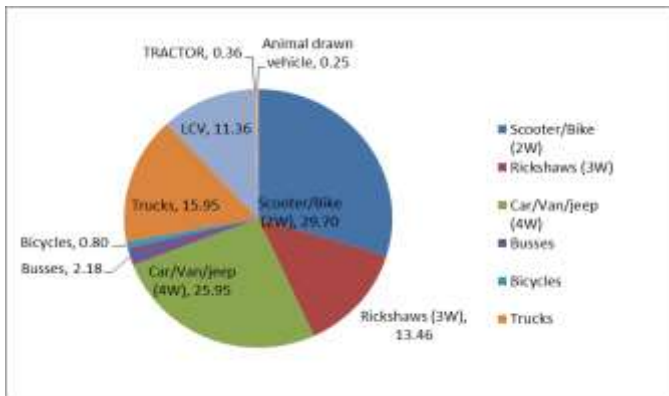**Fig -7**: Hourly vehicle composition at Palm hotel

Fig -8: Hourly vehicle composition at Dehgam circle

4.1.3 Speed measurements

The spot speed measurements were done on the selected locations of the S.P. ring road. The locations were selected as to get the 15th 50th 85th and 98th percentile speed. The spot speed measurements were carried out at the following locations.

1. Agora mall
2. Vaishnodevi circle
3. Shantipura circle
4. Sanathal circle
5. Nikol cross road
6. Palm hotel
7. Dastan vintage village hotel
8. Ranasan toll plaza

4.1.3.1 Time mean Speed

Time mean speed can be defined the average of the vehicles passing a point over a duration of time. It is the simple average of spot speed. Time mean speed v_t is given by,

Time mean speed,

Where,

v_t = time mean speed

N = total number of samples

4.1.3.2 Space mean speed

Space mean speed can be defined as the harmonic mean of speeds passing a point during a period of time. It also equals the average speeds over a length of roadway.

Space Mean Speed,

Where,

$$\overline{v_t} = \frac{1}{N} \sum_{n=1}^{N} v_n$$

V_s = spot speed

N = total number of samples

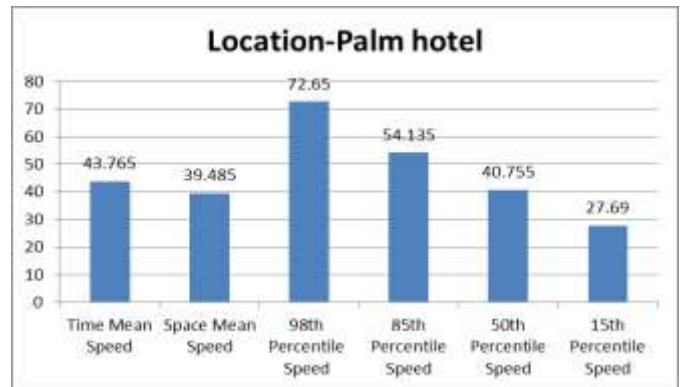The speed study results for various locations are as shown in figures from fig. 9 to fig. 16.

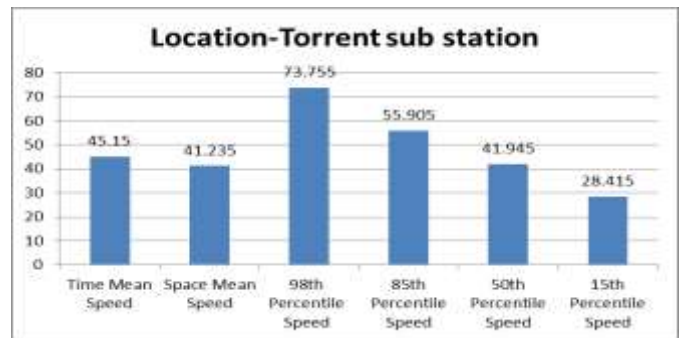**Fig -9**:-Spot speed study result at Palm hotel(odhav)

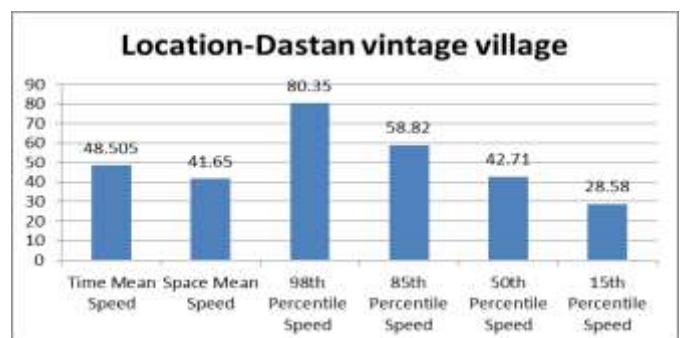**Fig -10**:-Spot speed study result at Torrent sub station

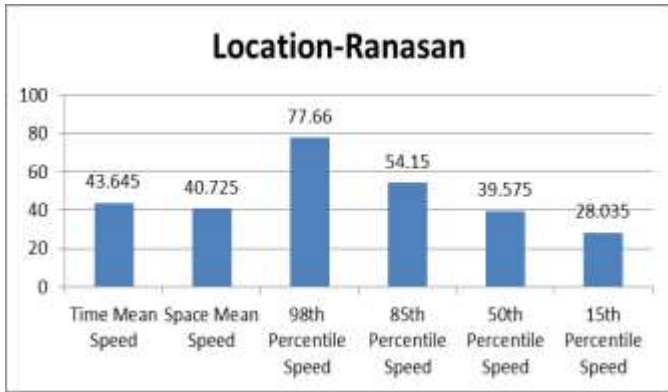**Fig -11**:-Spot speed study result at Dastan vintage village

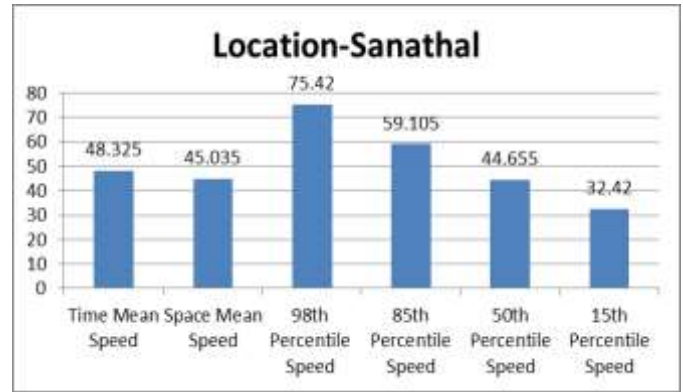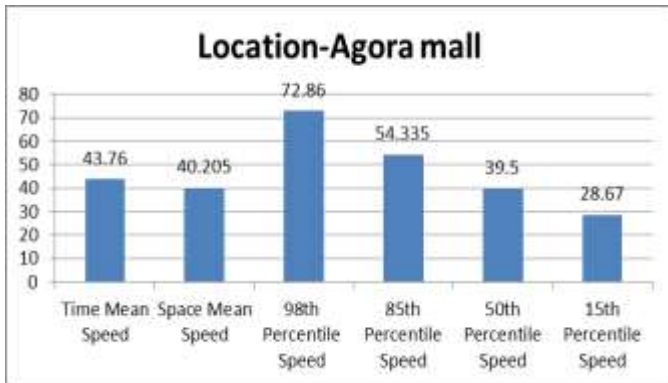**Fig -12**:-Spot speed study result at Ranasan toll

Fig -13:-Spot speed study result at Agora mall

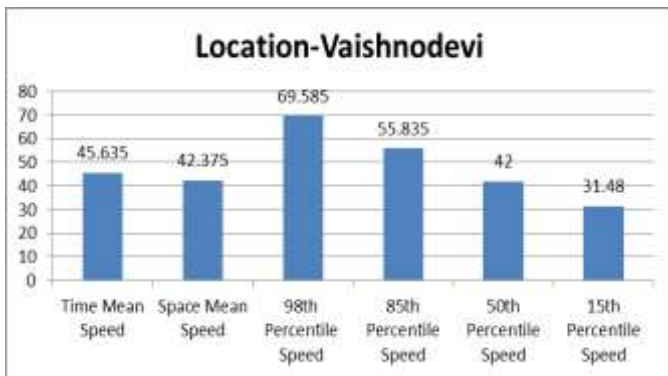**Fig -14**:-Spot speed study result at Vaishnodevi circle

Fig -15:-Spot speed study result at Shantipura circle
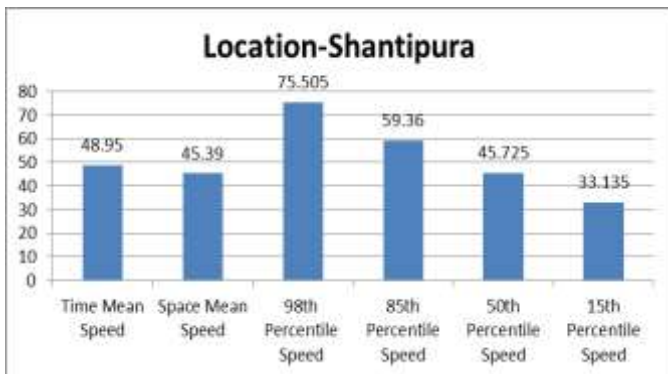

Fig -16:-Spot speed study result at Sanathal circle

5. DATA ANALYSIS

The accident data collected from police station studied and analyzed thoroughly. The collected data analyzed according to the various parameters like Yearly variation of accidents, Accident classification according to the time, Accidents classified according to month, Road user type and fatalities, Accident classified according to Collision type, Accident classified according to Vehicle Maneuver, Accident classified according to Accident spot. Blackspot identification was done according to MoRTH's definition of blackspot. The total numbers of accidents were compared with the chainage interval of 500 m. It was observed that S.P. ring road is having 18 black spots varies from North to South and East to West direction of Ahmedabad.

5.1 Application of qgis

The GIS software is used Qgis 2.18. The Black spots are located by Qgis software. Linear referencing was done by taking the latitude and longitude of the respective all accident record of 482. After that the data sheet was made run in QGis 2.18 software. The heat map plugin was used to create a buffer layer of which shows the intensity of the accidents with the respective locations. Google street map was used as the base layer.
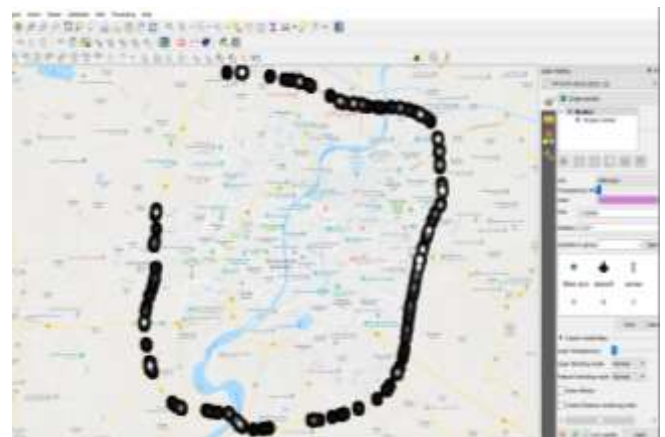

Fig -17: White dots shows the Accident Black Spots using GIS on S.P.ring road

6. CONCLUSIONS

The location which have the higher rate of accidents and the lack of the safety measures are termed as Accident black spots. This paper was an attempt to identify and analyze these black spots on Sardar Patel ring road and compare it with the most vulnerable segments across the road. Black spots were identified using heatmap plugin and the same were analyzed using information query tool in QGIS. Some observations have been done which is as under:-

1. Land use pattern along the study area corridor varies from residential, commercial, agricultural etc.

2. From traffic volume count it is observed that the maximum number. of vehicles are 2 wheelers which shares on an average 30.64 % and car/jeep/van shares on an average 27.17%.

3. Pedestrian and two wheelers are most vulnerable victims of the accidents on the stretch.

4. In the month of October, maximum number of accidents occurred.

5. From the analysis it is observed that maximum number of accidents occurs at rotary intersection

6. Major Black spots are having lack or severe conditions of road traffic signs and torn markings.

There are 18 black spots, the remedial measures for the same is described below:-

On S.P. ring road number of accident are taking place so traffic control and enforcement measures are essentially required. Number of particular places traffic sign and speed restriction sign boards are required.

- For pedestrian facilities provision of zebra crossing, walk way, overpasses/ under passes whenever necessary.

- Driver's training is essential whenever issuing license.

- Work hours of drivers should be reduced

- The police patrolling is required at night time because some of the drivers are having drugs or other alcoholic drink that may causes an accidents.

- Provision of the signage for the converging & merging of lanes, other signs required at suitable places

- On the cut in median, the distance between signage needs to be increased for proper visibility of signage at the median.

- The numbers of the cuts should be minimizing at service lane to avoid conflict points because of ribbon development along the stretch.

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