Rural Road Safety Course

Crash Data Analysis & Black Spot Treatment

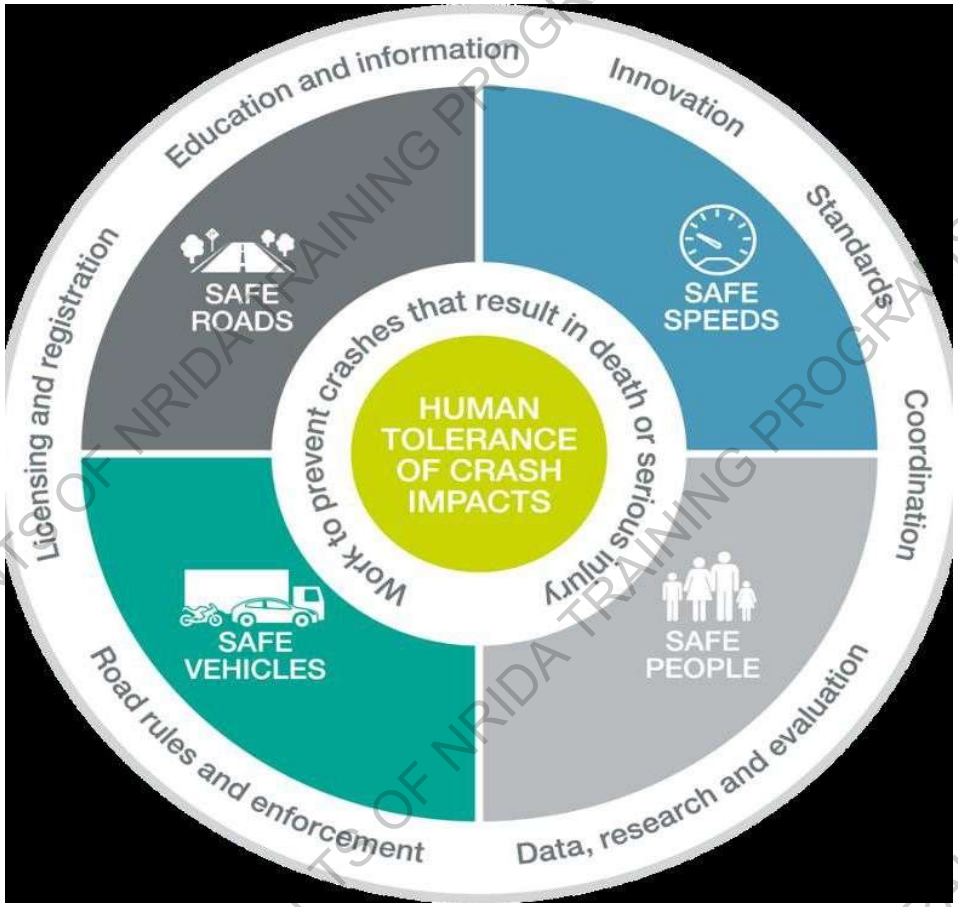
Introduction

- This lecture provides guidance towards identification of blackspots, crash data analysis and improvement for road crash prone locations through engineering interventions.
- It also provide practical guidance in carrying out blackspot improvement programme.
- Location specific and infrastructural measures can be implemented to decrease number of crashes. This can be defined as “treating the blackspot sites”.
- Blackspot improvement is a crash data led investigation process to understand the causes of road crashes and then to design and implement matching countermeasures.

Road Safety Improvements Approaches

Safe Systems Approach：

- SSA built on the premise that deaths and serious injuries are not acceptable in road systems and no road user should be exposed to the level of kinetic energy that may result in death or serious injuries in road system.
- SSA is promoted by The Netherlands as Sustainable Safety and in Sweden as the “vision zero” policy.
- Sustainable Safety can be achieved by a proactive approach in which human characteristics are used as starting point.
- These characteristics refer on the one hand to human physical vulnerability and on the other hand to human (cognitive) capacities and limitations.



Key Principles of Safe System Approach (SSA)

- Principle 1 : Recognition of human frailty
- Principle 2 : Acceptance of human error
- Principle 3 : Creation of a Forgiving environment and appropriate crash energy management.

Thus design of roads play an important role in road safety and improved geometric design of road infrastructure could in turn improve road safety.

Engineering Interventions

Definition of road crash

A road crash is a multi factor event always preceded by a situation in which one or more road users have failed to cope with the road environment, resulting in a vehicle collision

- Road engineering should be helping road users to more easily cope with the road – its layout , safety features, and other facilities like providing proper signage and road markings, foothpath, pedestrian crossing, speed controlling devices channelization/segregation wherever possible.

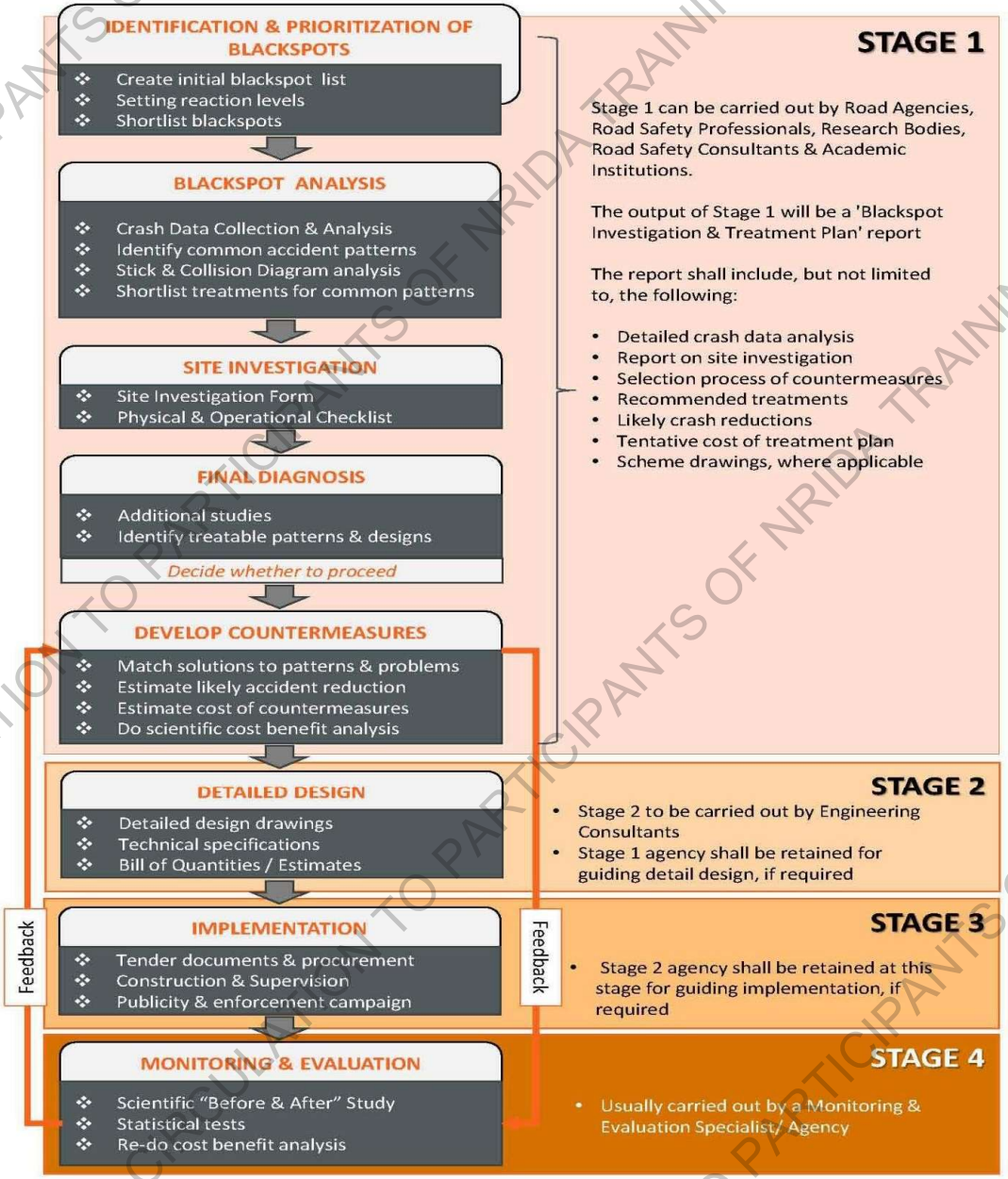
Approaches to the task of treating roads with bad accidents records –

- **Single site scheme or blackspot programme** : treatment of individual sites (e.g. junctions, bends or short (500m) of road in which road crashes are clustered by safety engineering interventions.
- **Route action scheme** : safety treatments applied to the whole length of road which has overall bad crash record.
- **Mass action scheme** : standard treatments are applied to locations having incidences of common type of road crashes.
- **Area action scheme** : safety treatments will be applied throughout an area having bad overall road crash record.

Black Spot Treatment Process

- In blackspot improvement programme , road traffic crashes are analyzed spatially for fixed period of years (3 to 5 years) and where localized higher density of road crashes are identified (clusters) these can indicate that there are deficiencies with the road environment.

- Thereafter, suitable remedial measures should be devised and undertaken to rectify the defects to reduce incidences of road crashes and fatalities on identified road stretch.



Crash Data Collection

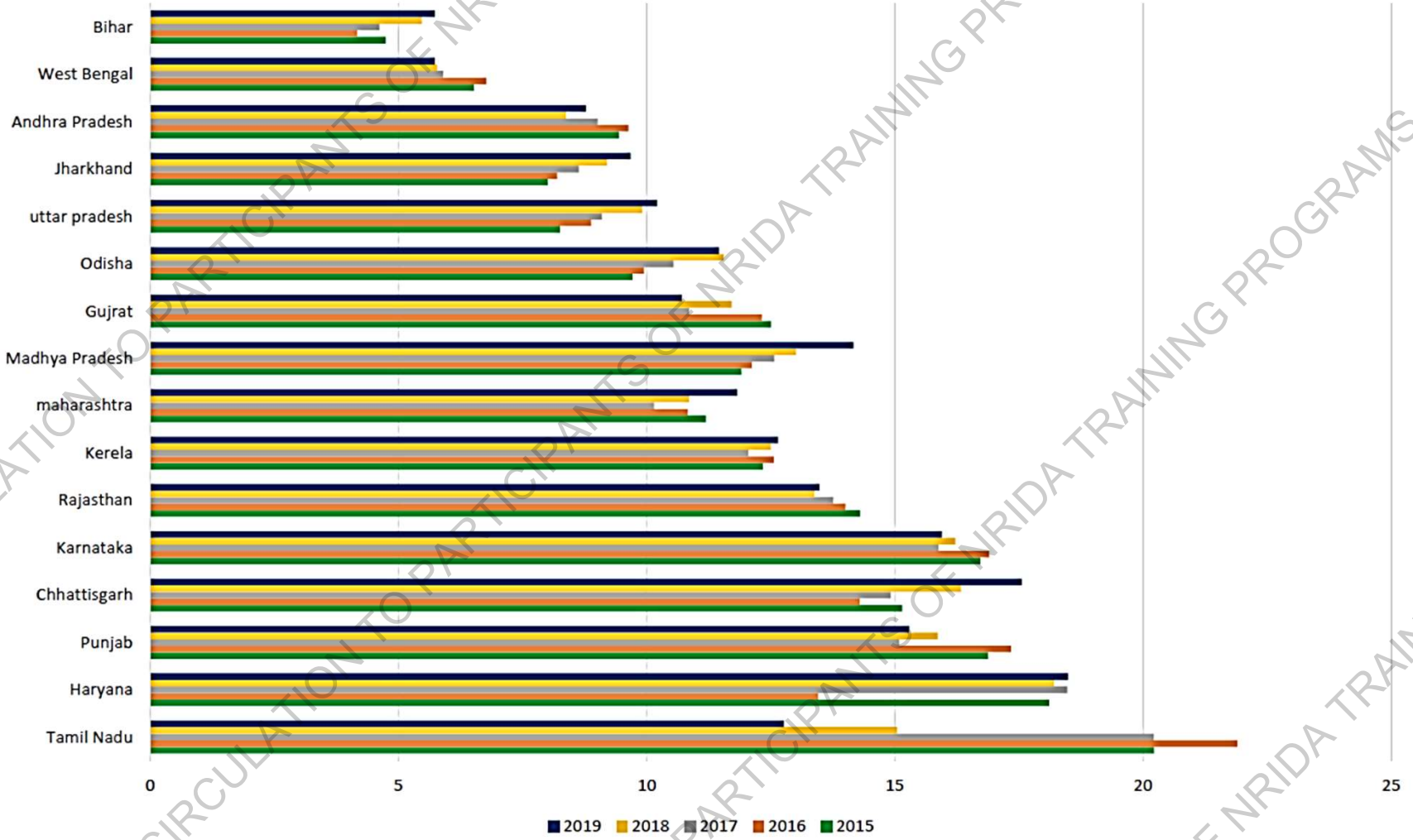
- It is carried out across the road network only by the police in all states of the country, whenever a road crash happens.

- Since 2009, ministry of home affairs (MHA) has been working on crime and criminal tracking network systems (CCTNS) to automate police functions at police stations, and also create facilities and mechanism to provide public service like registration of online complaints, ascertaining the status of case registered at police station and verification of persons.

- Recently, some of the states have implemented GIS enabled web based Road Crash Data Management Systems confirming to IRC:53 or formats recommended by MoRTH.

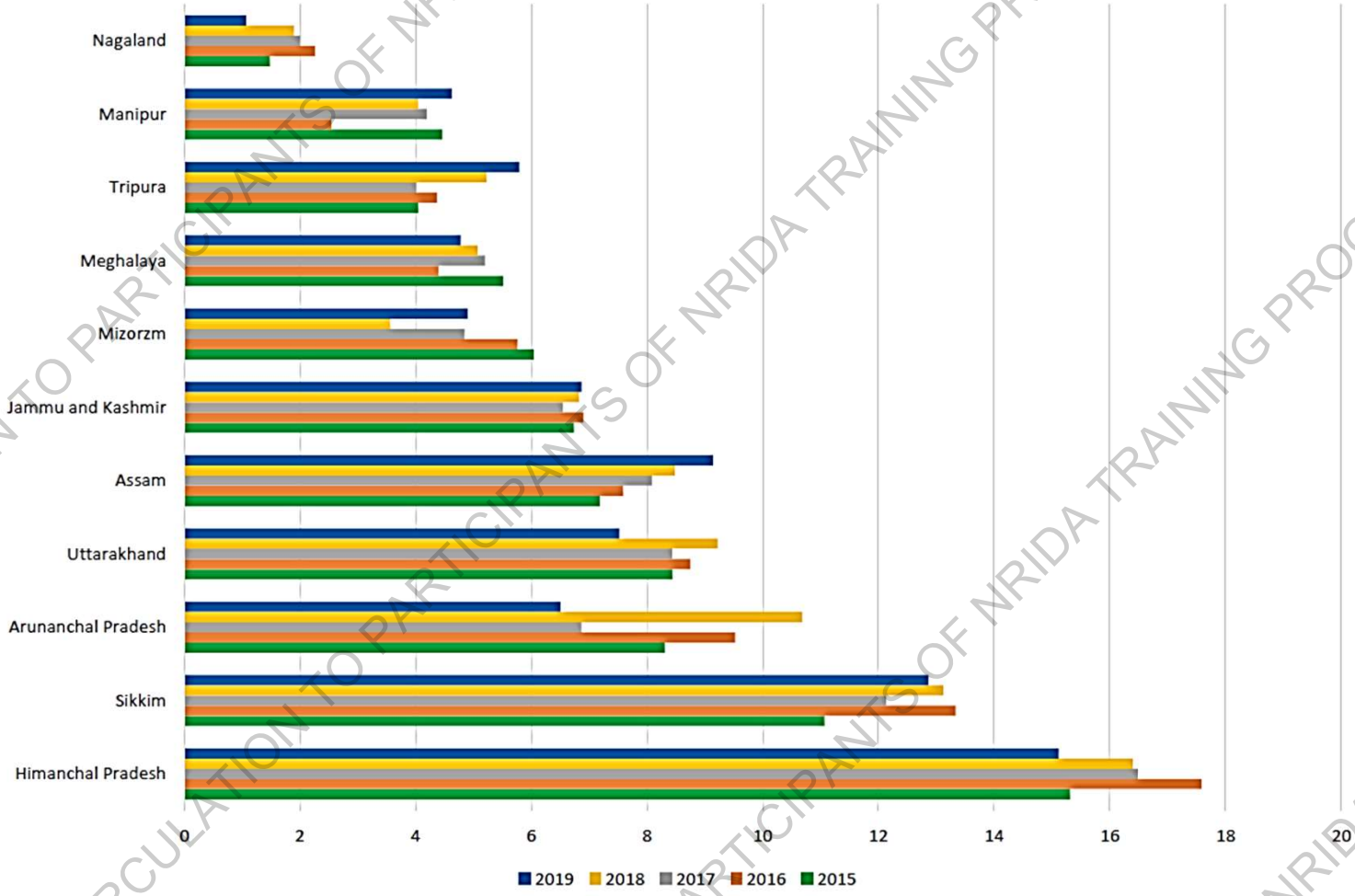
Fatalities per 100 thousand population in States

Highest number of Fatalities per thousand population among big states are observed in Tamil Nadu, Haryana, Punjab and less Fatalities in Bihar.



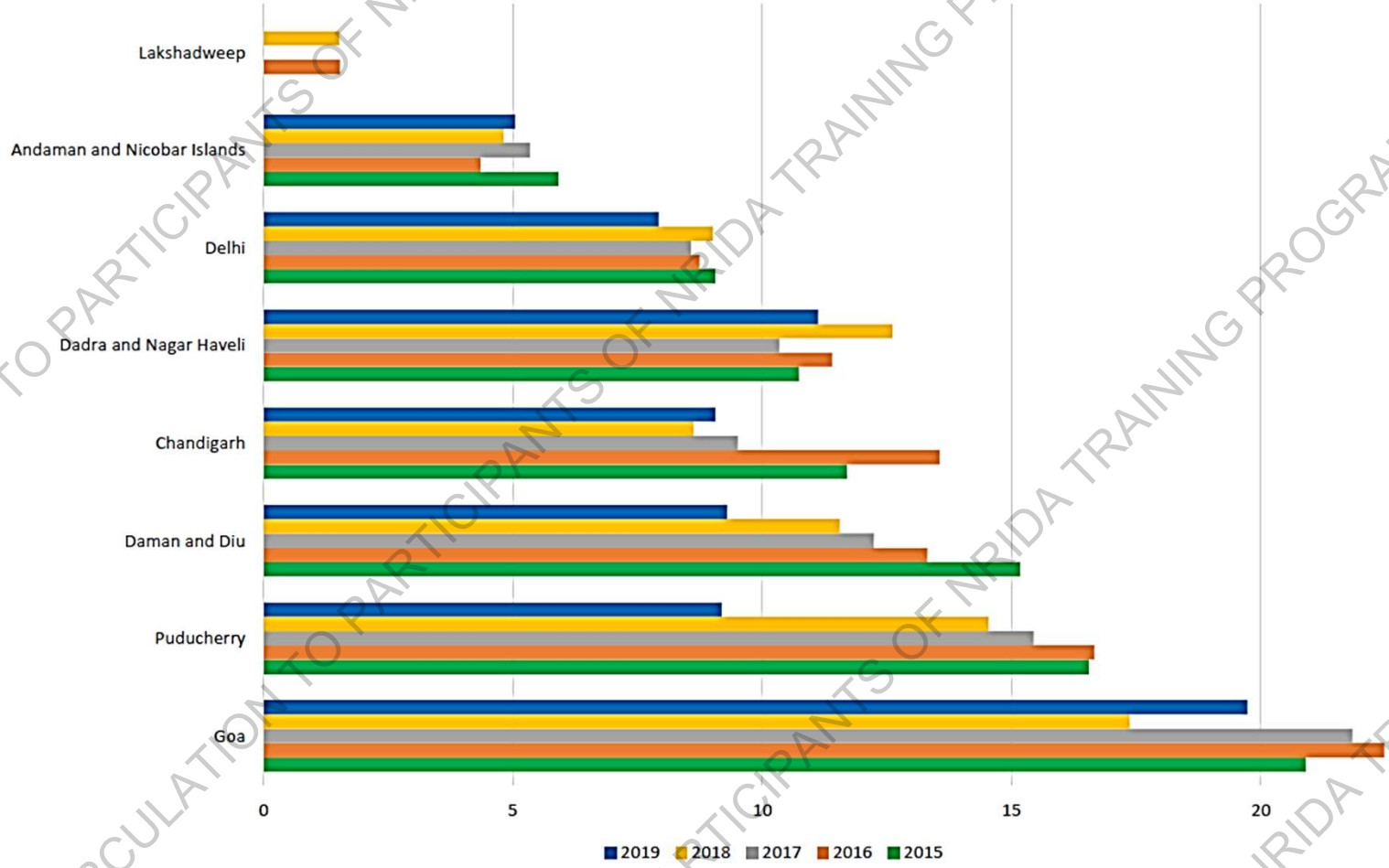
Fatalities per 100 thousand population in hilly States

Highest number of Fatalities per 100 thousand population among hilly States are observed in Himachal Pradesh and Sikkim.

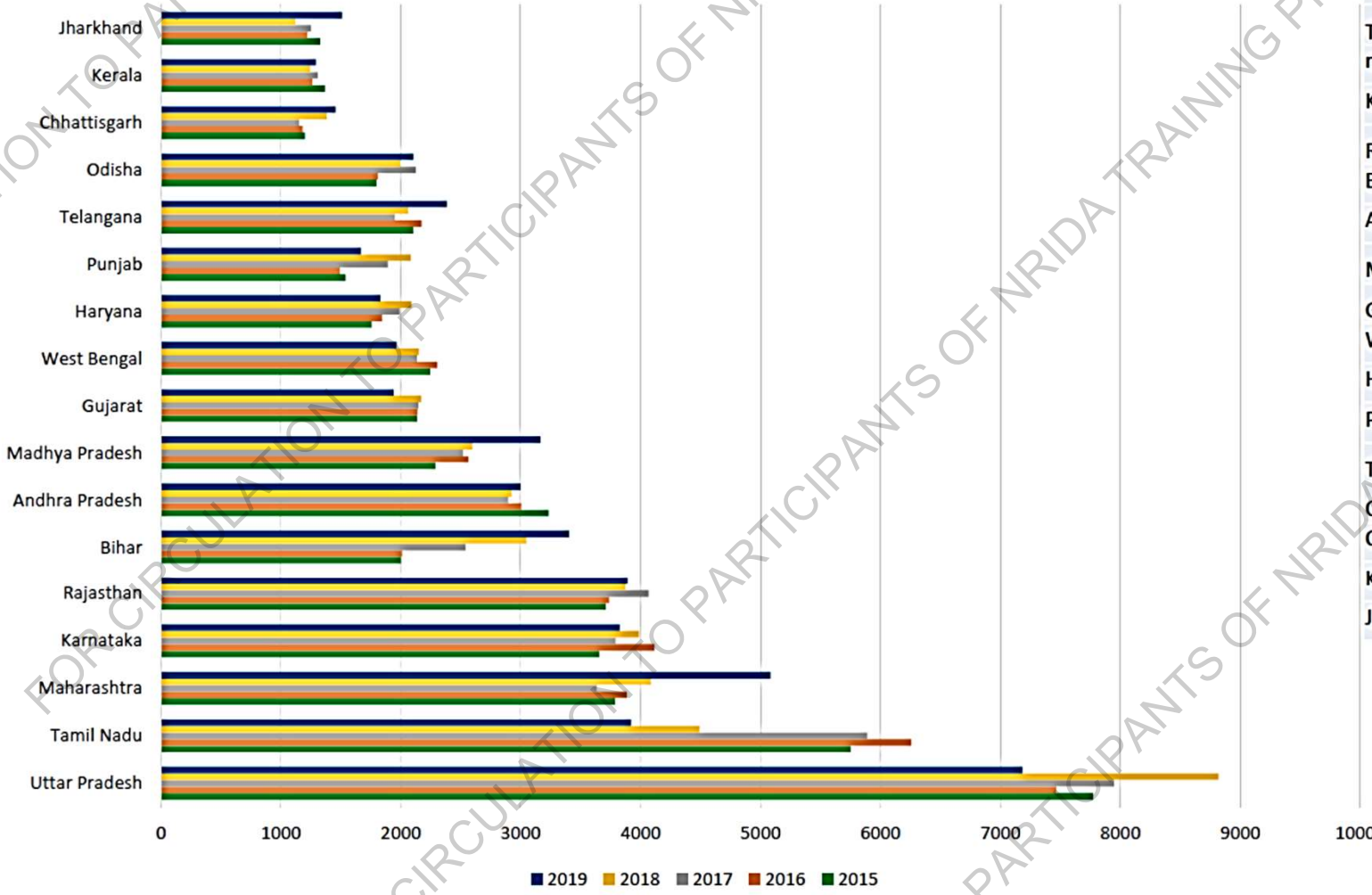


Fatalities per 100 thousand population in UTs

Highest number of Fatalities per 100 thousand population among the UT's are observed in Goa and Puducherry.

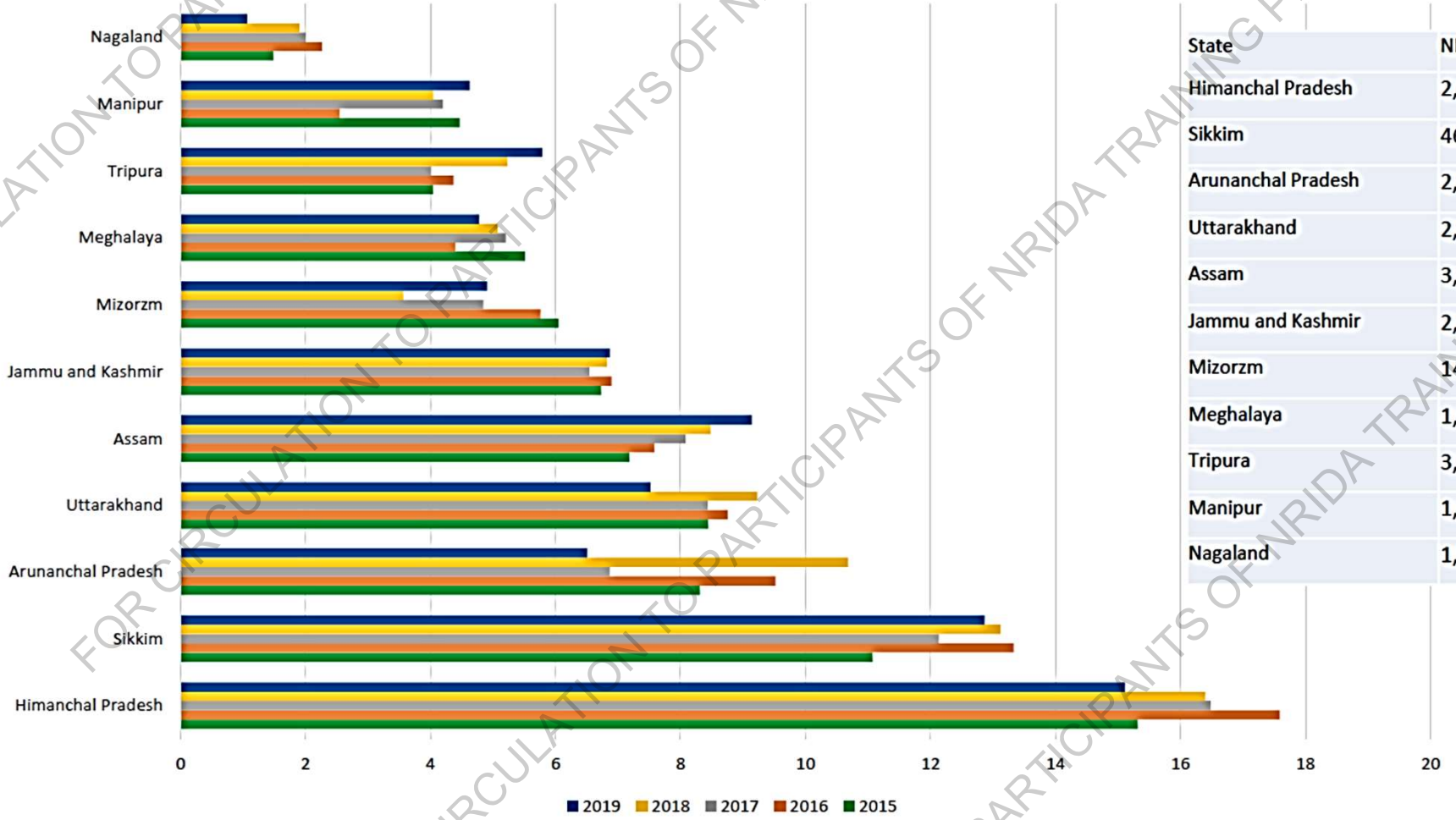


Total number of persons killed in road accidents on National Highway in States



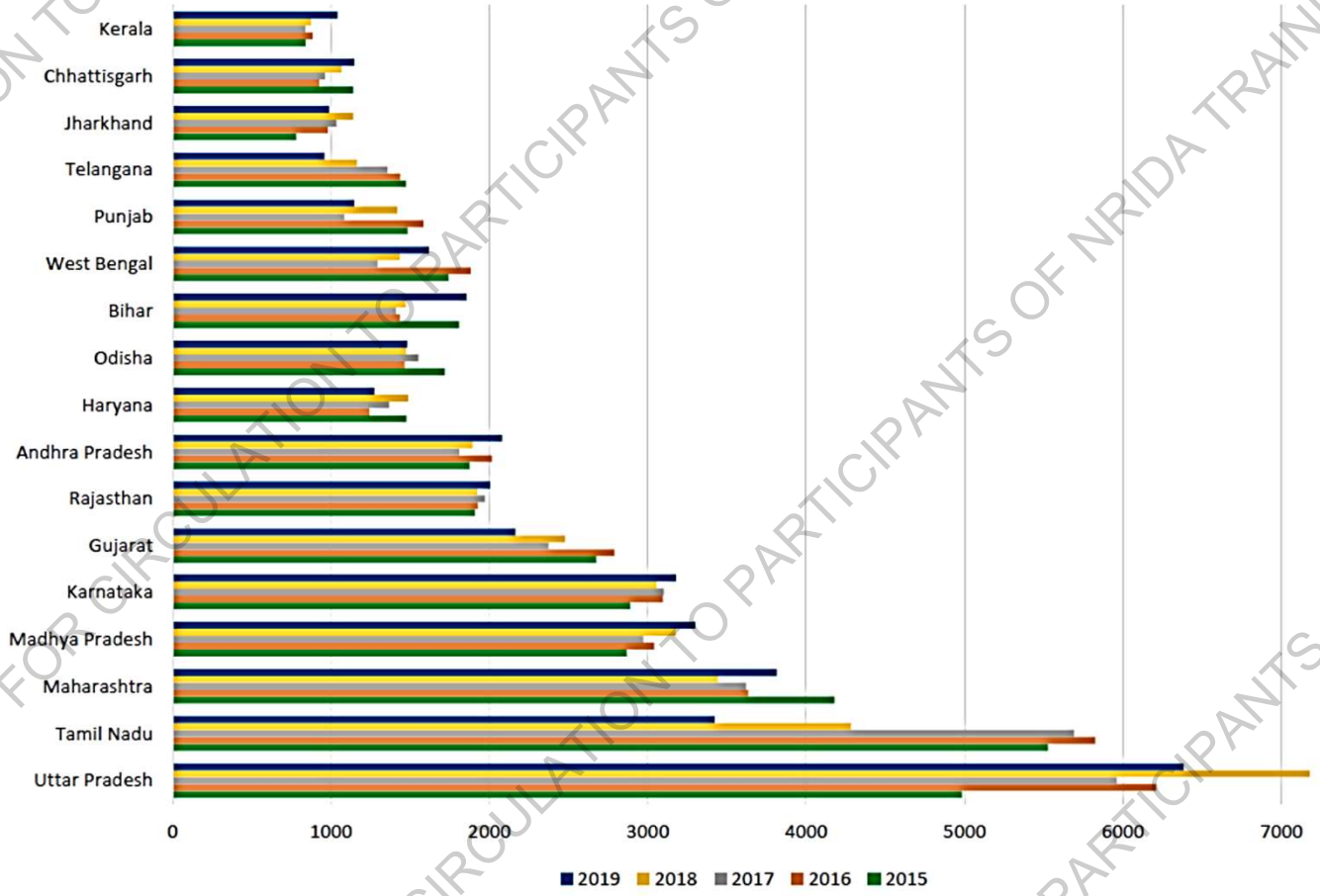
State	NH length (Km)
uttar pradesh	8,711
Tamil Nadu	5,381
maharashtra	15,437
Karnataka	6,761
Rajasthan	7,906
Bihar	4,839
Andhra Pradesh	6,286
Madhya Pradesh	7,884
Gujrat	5,017
West Bengal	2,998
Haryana	2,641
Punjab	2,769
Telangana	854
Odisha	4,837
Chhattisgarh	3,232
Kerela	1,782
Jharkhand	2,661

Total number of persons killed in road accidents on National Highway in Hilly States



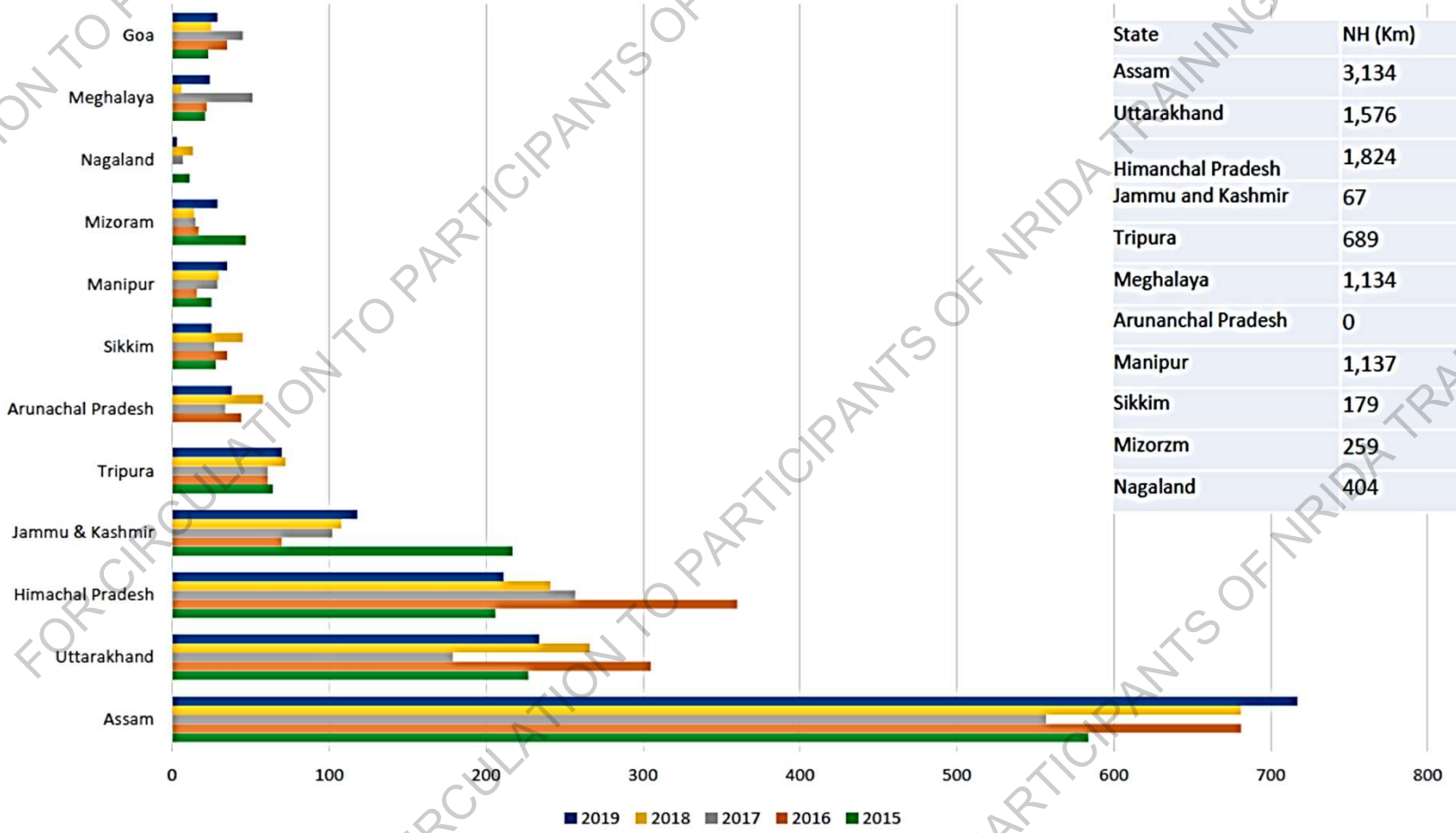
State	NH (Km)
Himanchal Pradesh	2,643
Sikkim	463
Arunanchal Pradesh	2,537
Uttarakhand	2,842
Assam	3,845
Jammu and Kashmir	2,601
Mizorzm	1422.5
Meghalaya	1,204
Tripura	3,786
Manipur	1,746
Nagaland	1,547

Total number of persons killed in road accidents on State Highway in States



State	SH length (Km)
uttar pradesh	8,432
Tamil Nadu	26,985
maharashtra	33,705
Madhya Pradesh	8,728
Karnataka	20,738
Gujrat	19,761
Rajasthan	11,716
Andhra Pradesh	10,518
Bihar	3,766
Telangana	3,260
West Bengal	2,991
Odisha	3,806
Haryana	2,523
Punjab	1,393
Chhattisgarh	3,419
Kerela	4,341
Jharkhand	1,886

Total number of persons killed in road accidents on State Highway in Hilly States



State	NH (Km)
Assam	3,134
Uttarakhand	1,576
Himanchal Pradesh	1,824
Jammu and Kashmir	67
Tripura	689
Meghalaya	1,134
Arunanchal Pradesh	0
Manipur	1,137
Sikkim	179
Mizorzm	259
Nagaland	404

- Road Accidents in India - 2019 (1.20 Mb)
- Road Accidents in India - 2018 (Corrigendum dated 20-02-2019) (661.33 Kb)
- Road Accidents in India - 2018 (32.17 Mb)
- Road Accidents in India - 2017 (8.80 Mb)
- Road Accidents in India - 2016 (7.13 Mb)
- Road Accidents in India - 2015 (7.90 Mb)
- Road Accidents in India - 2014 (2.67 Mb)
- Road Accidents in India - 2013 (2.35 Mb)
- Road Accidents in India - 2012 (1.49 Mb)
- Road Accidents in India - 2011 (2.16 Mb)
- Road Accidents in India - 2010 (2.83 Mb)
- Road Accidents in India - 2009 (5.12 Mb)
- Road Accidents in India - 2008 (576.55 Kb)

Definition of Blackspots (MORTH)

Definition of Black spot (MoRTH): According to Ministry of Road Transport & Highways (MoRTH), Government of India, road accident black spot on National Highways is a road stretch of about 500m in length in which either 5 road accidents (involving fatalities/grievous injuries) took place during last three calendar years or 10 fatalities took place during last three calendar years.

Severity of Blackspots (NHAI)

According to National Highway Authority of India (NHAI), hazardous locations are evaluated based on *Accidents Severity index (ASI)*. Hazardous spots with Accidents Severity Index (ASI) more than Threshold value (Average Severity + 1.5*Standard Deviation) will be treated as Black spots. For estimation of ASI, the weightage to fatal accident will be assigned as 7 and to grievous injury accident as 3, was considered based on NHAI's criteria.

The threshold value computation formula for first order, second order, third order, fourth and fifth order priority black spots are given in **Table 1.**

Severity of Blackspots (NHAI)

Table 1: Threshold value of priority black spots

Priority	Threshold value
First order black spots	Average Severity + 1.5*Standard Deviation
Second order black spots	Average Severity + Standard Deviation
Third order black spots	Average Severity + 0.5*Standard Deviation
Fourth order black spots	Average Severity
Fifth order black spots	Below Average Severity

Another School of Thought:

- Blackspot is a road section of 300-500m length that has an abnormally high number of road crashes showing a pattern of road crash types due to some underlying local risk factors.
- Volume of traffic in most of the NHs/SHs are substantially high and hence the crash frequency and fatalities are high ; the above classes of highways (including expressways) continue to account for the 55-60% of the overall crashes and deaths in the last decade.
- An uniform guiding value cannot be applied across the country for identifying blackspots, it has to be state specific as well as according to road class.

Identification of blackspots

AVERAGE ANNUAL TOTAL CRASH VALUES : Stepwise procedure to find AACTV

- ✓ Three year fatality data is collected from official sources.
- ✓Road lengths is collected from official website of MoRTH.
- ✓Annual Average Total Crashes collected over 3 year period are divided by respective road lengths to get AATC/Km
- ✓AATC is further divided to get AATC for 500m of road length.
- ✓AATC/500m is multiplied by suitable factors (3 to 15 times that is setting reaction level) to arrive at a number for the particular state considered in the analysis.

SETTING REACTION LEVEL : The reaction level for identifying the blackspots could be 3 times or 5 times or 10 times or 15 times.

- Those road sections (with crash clusters) securing more than 15 times AATC can be termed as 1st order blackspots whereas between 10-15 times AATC and 5-10 times AATC and 3-5 times AATC are termed respectively as 2nd, 3rd and 4th order blackspots.

BLACKSPOTS IDENTIFICATION USING A CRASH DATA MANAGEMENT SYSTEM :

Blackspots can be identified using various methods including spatial analysis, cluster analysis, corridor analysis etc.

PRIORITIZATION OF BLACKSPOT FOR TREATMENT

- **Identified list of blackspots has to be prioritized for treatments. It is done by severity indices.**
- Severity indices : severity score shall be assigned with values given below

1)Fatal road crashes – 10 points

2)Serious injury crashes – 5 points

3)Minor injury crashes – 2 points

4)Damage only crashes – 1 point

IDENTIFICATION BLACKSPOSTS USING A CRASH DATA MANAGEMENT SYSTEM

1) Cluster Analysis
2) Heat Map Analysis
3) Corridor Analysis

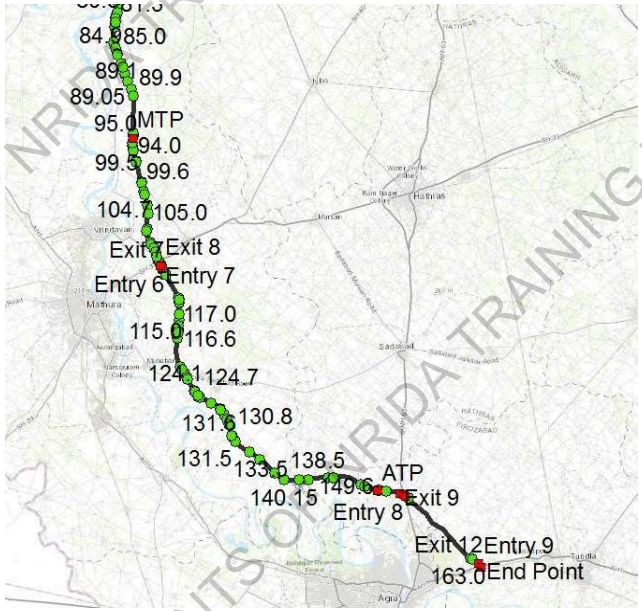


Figure 4-3 Corridor Analysis in a Crash Data System

BLACKSPOTS –PRIORITZATION

Table 4-1 Total Severity Score (Worked out example)

Location	Number of Accidents				Total Severity Score
	Fatal	Major	Minor	Damage Only	
	Severity Score				
	10	5	2	1	
Accident Clustered Location 1	1	3	2	3	32
Accident Clustered Location 2	0	10	5	0	60
Accident Clustered Location 3	5	2	3	7	73
Accident Clustered Location 4	0	1	2	7	16
Accident Clustered Location 5	0	1	0	2	7
Accident Clustered Location 6	0	0	2	1	5
Accident Clustered Location 7	8	0	1	1	83
Accident Clustered Location 8	1	1	2	8	27
Accident Clustered Location 9	1	1	3	5	26
Accident Clustered Location 10	0	0	4	2	10
Accident Clustered Location 11	2	2	3	12	48
Accident Clustered Location 12	2	3	1	10	47
Accident Clustered Location 13	0	0	0	6	6
Accident Clustered Location 14	2	0	3	2	28
Accident Clustered Location 15	7	5	0	0	95

BLACKSPOTS – PRIORITZATION

Table 4-2 Blackspot for Treatment in the Order of Priority (Worked out example)

Location	Number of Accidents				Total Severity Score	Blackspot for Treatment in the Order of Priority
	Fatal	Major	Minor	Damage Only		
	Severity Score					
	10	5	2	1		
Accident Clustered Location 15	7	5	0	0	95	Blackspot 1
Accident Clustered Location 7	8	0	1	1	83	Blackspot 2
Accident Clustered Location 3	5	2	3	7	73	Blackspot 3
Accident Clustered Location 2	0	10	5	0	60	Blackspot 4
Accident Clustered Location 11	2	2	3	12	48	Blackspot 5
Accident Clustered Location 12	2	3	1	10	47	Blackspot 6
Accident Clustered Location 1	1	3	2	3	32	Blackspot 7
Accident Clustered Location 14	2	0	3	2	28	Blackspot 8
Accident Clustered Location 8	1	1	2	8	27	Blackspot 9
Accident Clustered Location 9	1	1	3	5	26	Blackspot 10
Accident Clustered Location 4	0	1	2	7	16	Blackspot 11
Accident Clustered Location 10	0	0	4	2	10	Blackspot 12
Accident Clustered Location 5	0	1	0	2	7	Blackspot 13
Accident Clustered Location 13	0	0	0	6	6	Blackspot 14
Accident Clustered Location 6	0	0	2	1	5	Blackspot 15

BLACKSPOT ANALYSIS

Table 5-1 Example of Summary Analysis

Collision	Crashes					Crashes 3-yr total			
	Year			3-yr total	%	Fatal	Grievous Injury	Minor Injury	All
	2017	*2018*	*2019*						
Head on	2			2	10	2	1	5	8
Rear end									
Right angle	*2*	*2*	*4*	8	38	1	35	14	50
Side swipe		*1*		1	5		1	2	3
Overturned		*1*	*1*	2	10		1	16	17
Hit object on road		*1*		1	5			1	1
Hit object off road									
Hit parked Veh									
Hit pedestrian	*2*	*2*	*2*	6	29	4	1	1	6
Other		*1*		1	5		1	1	2
Total	**6**	**8**	**7**	**21**	100	**7**	**40**	**40**	87
Night				4	19				
Day				*17*	81				
Wet				*5*	24				
Dry				*16*	76				

BLACKSPOT ANALYSIS

1)Detailed Road Crash Data Collection : The investigating team/expert must visit the police station and gather data from the FIR of each case of road crash for the shortlisted blackspots.

2)Prepare Summary Analysis :

- Type of crash
- Severity of crash
- Type of Victims
- Type of vehicle involved
- Type of injuries

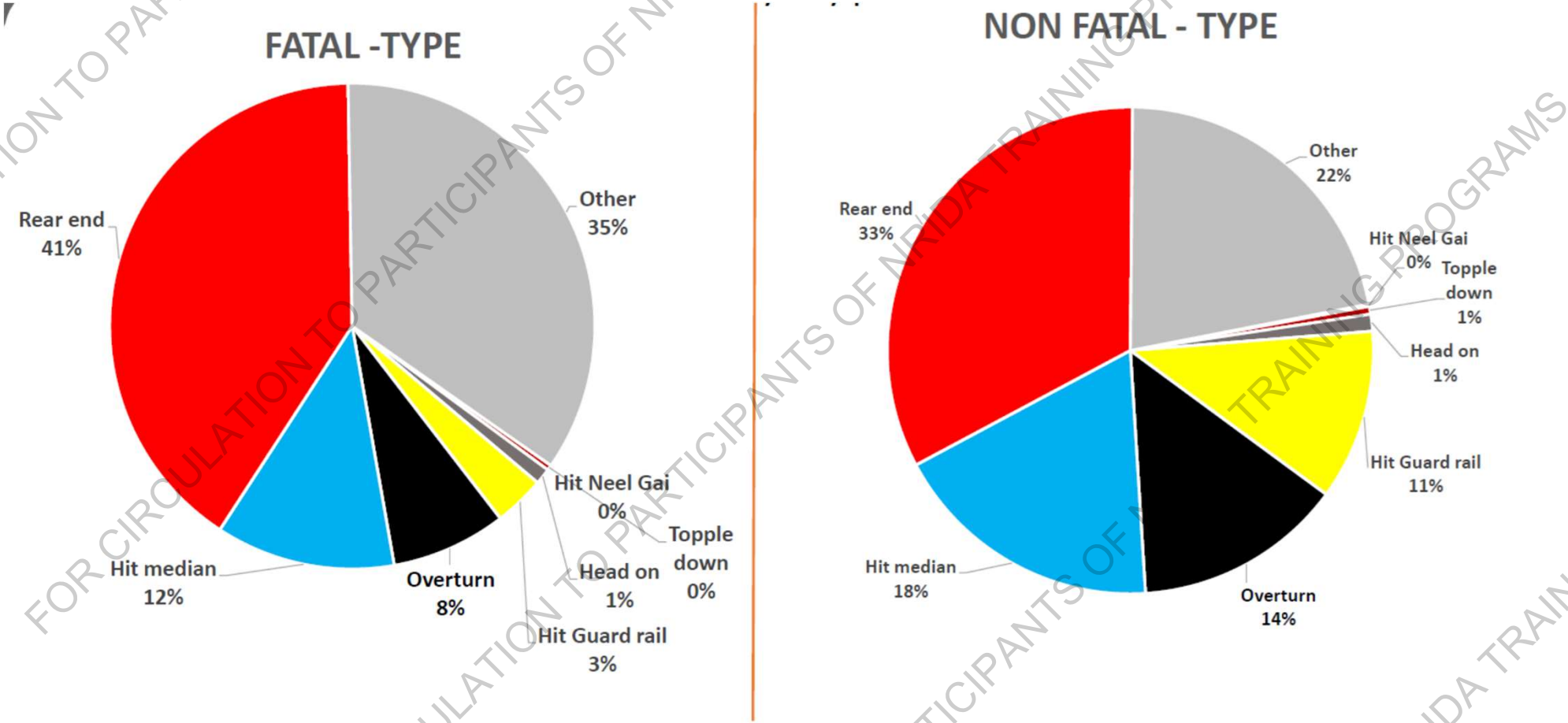
Crash Data Analysis

Overview of Crashes for Analysis

Table 1 Summary of Yearly Crashes Fatal and Non Fatal

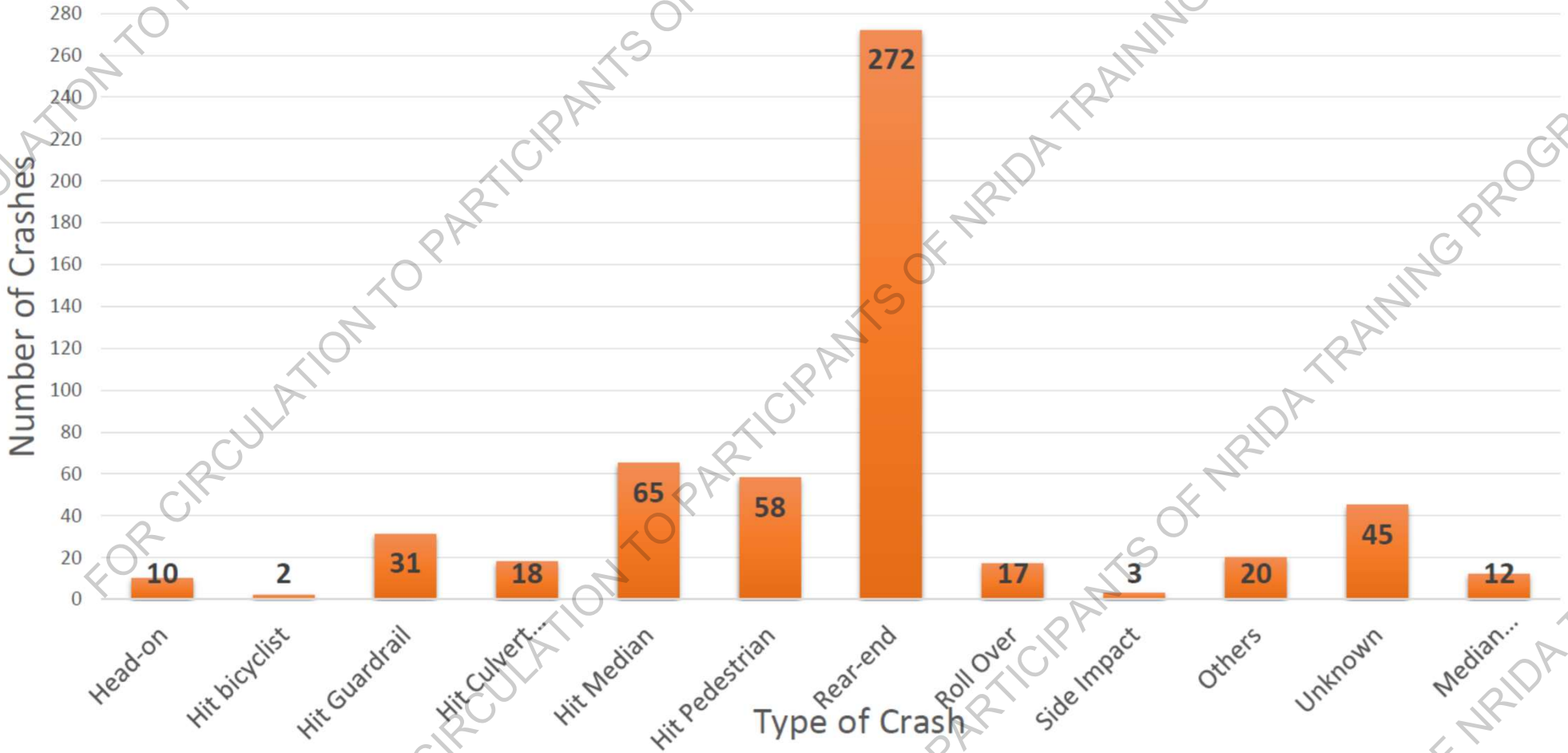
Year	Fatal Crashes			Non-Fatal Crashes
	No. of Crashes	Fatalities	No. of Injuries	No. of Crashes
From Sept 2012	19	24	43	233
2013	84	113	197	785
2014	98	127	225	674
2015	100	137	237	819
2016	96	123	219	1008
2017	109	142	251	645
Till Aug 2018	54	72	126	393
Total	**560**	**738**	**1298**	**4557**

Fatal and Non Fatal Crashes by Type of First Event

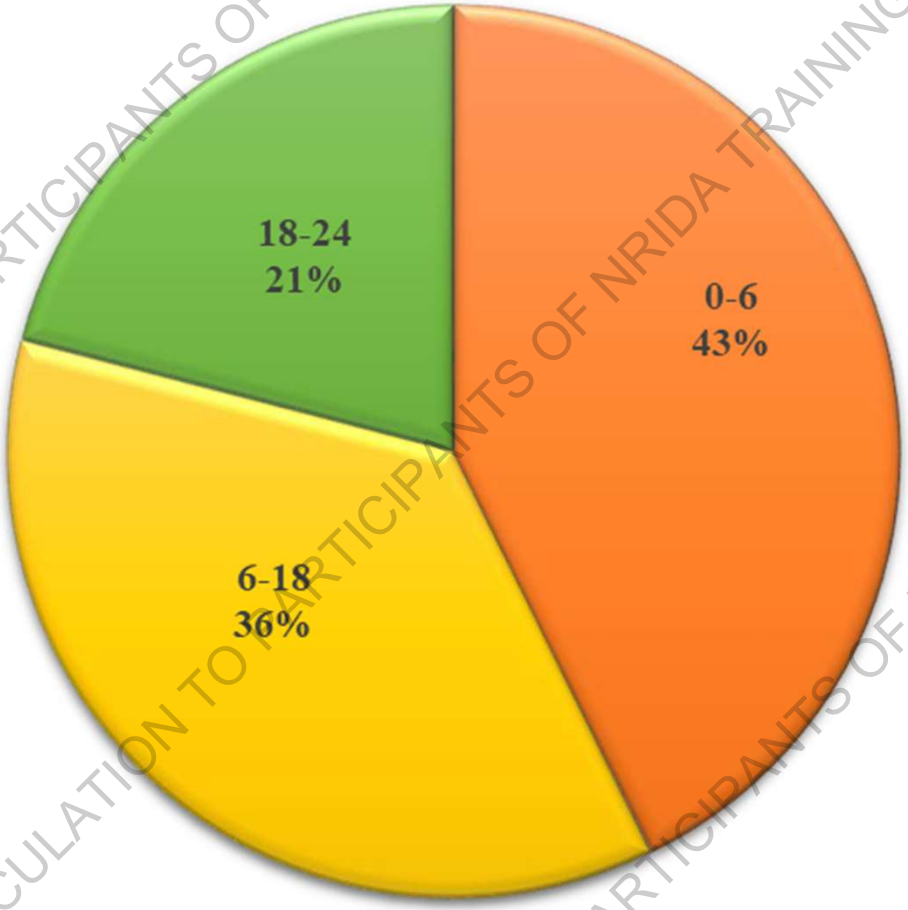


- Fatal and Non-Fatal Crashes proportion by **type of first event are almost similar.**

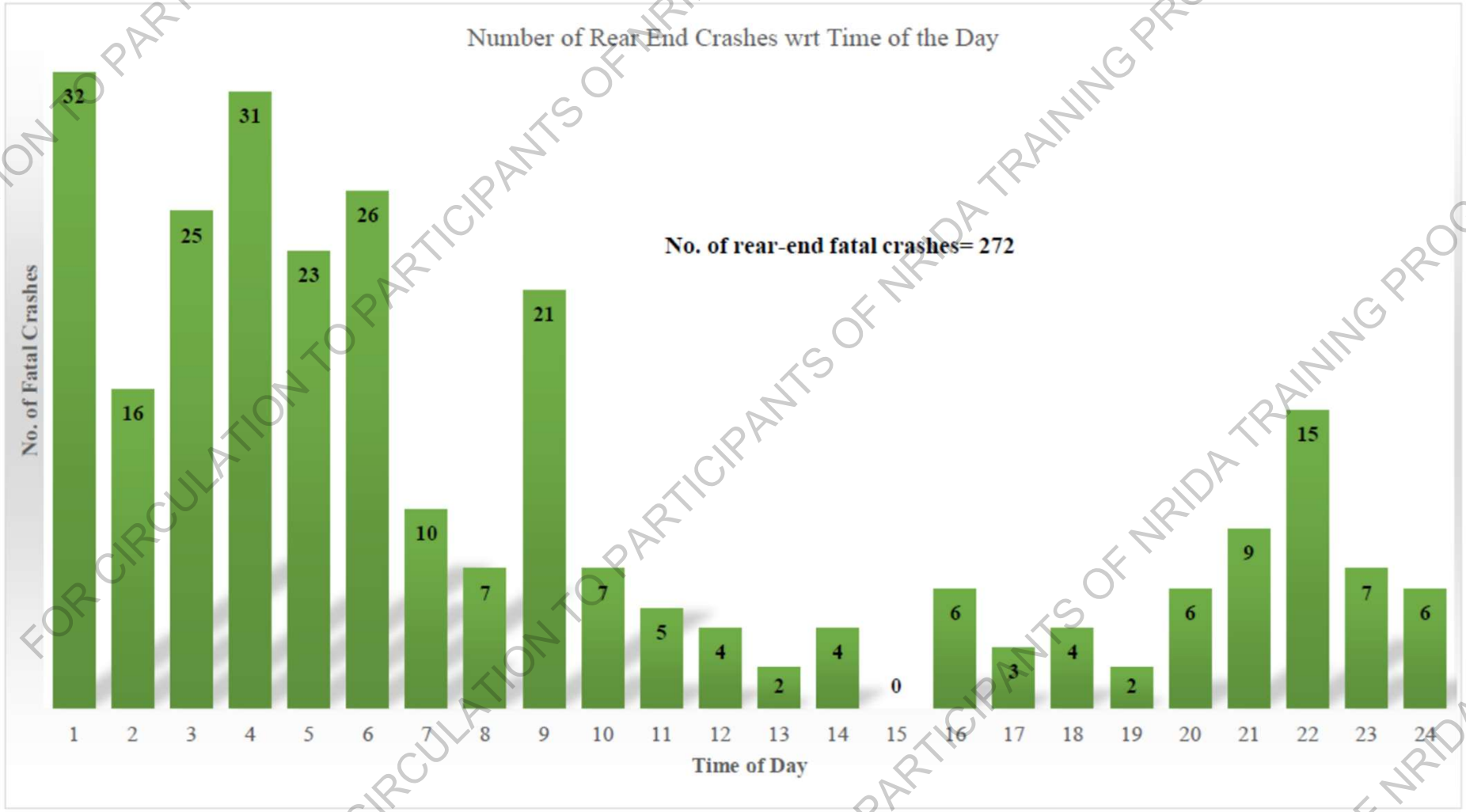
Total Number of Crashes by the Type of Crash



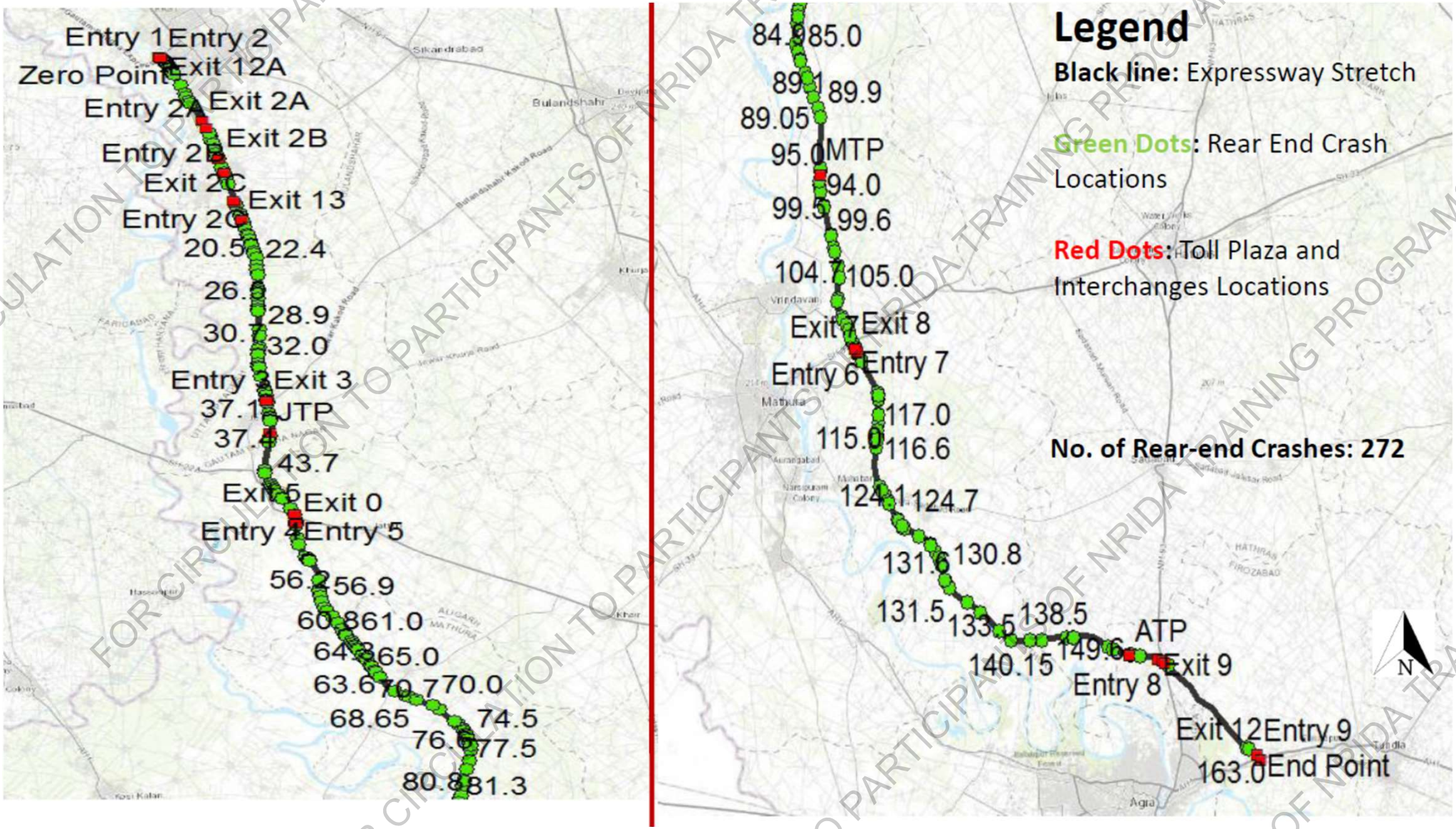
Proportion of Crashes According to the Time of Day



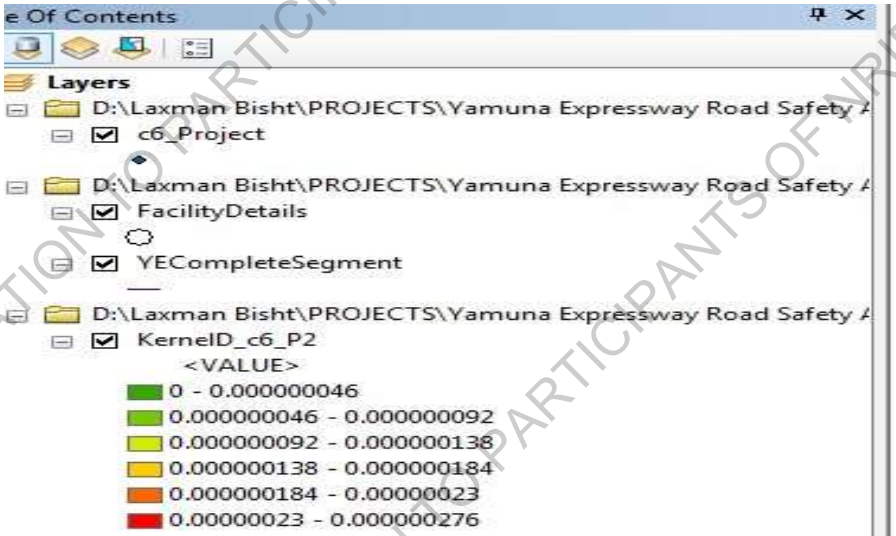
Number of Rear End Crashes w.r.t. Time of Day



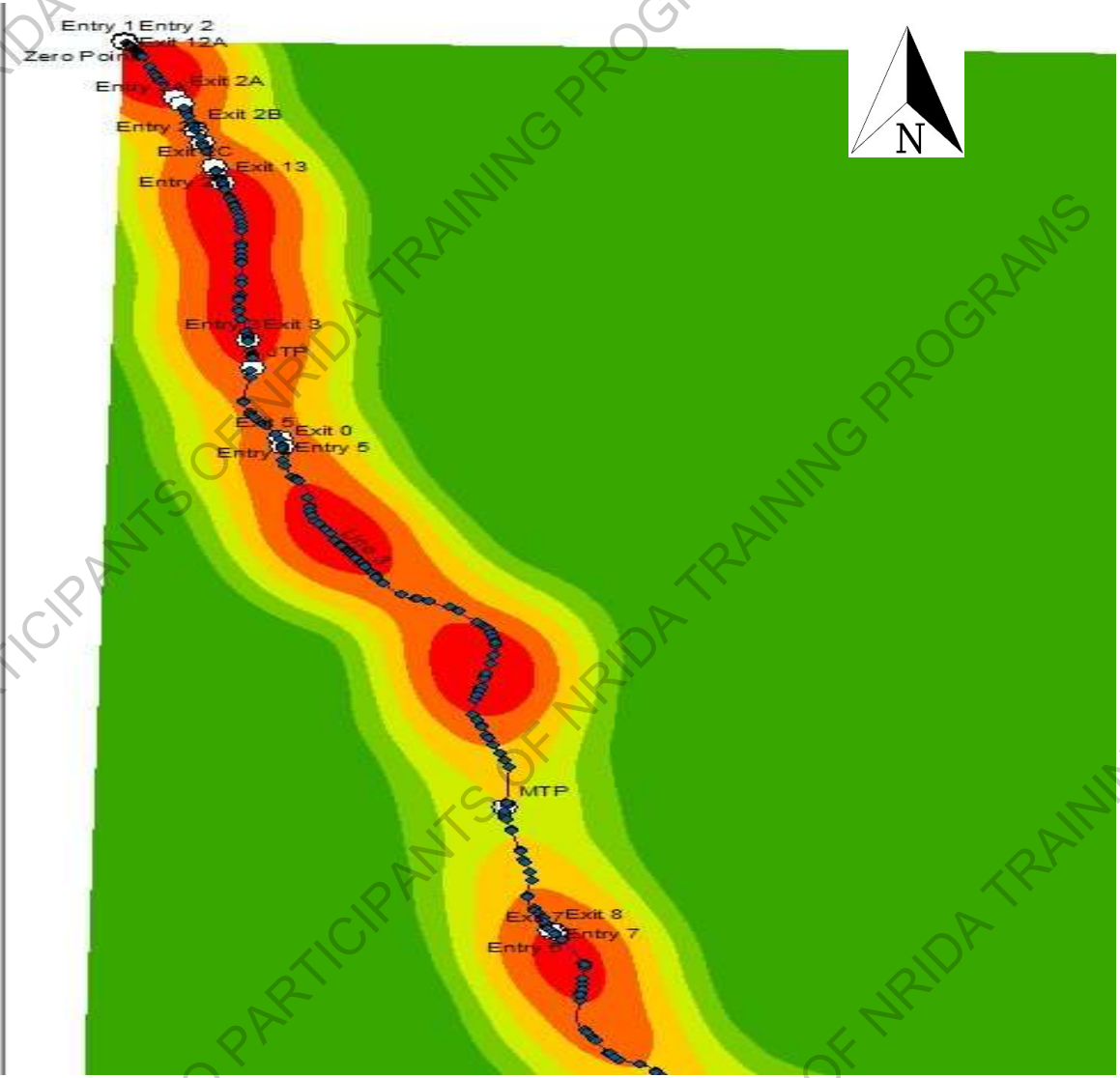
Rear End Crashes w.r.t. Facility Location



Density (KDE) of Rear End Crashes



Red section has the highest concentration of RE Crashes



Accident Distribution Along the Chainage

Average Rate: 3.39 Accident per km

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 km avg	16.0	13.0	8.0	5.0	3.0	5.0	4.0	3.0	8.0	5.0	3.0	1.0	6.0	4.0	1.0	5.0	5.0	**6.0**	**6.0**	5.0	4.0	4.0	2.0	0.0	2.0
2 km avg	14.5	14.5	10.5	6.5	4.0	4.5	4.5	5.5	6.5	6.5	4.0	3.5	5.0	5.0	3.0	5.0	5.5	**6.0**	**6.0**	5.5	4.5	4.0	3.0	1.0	2.5
3 km avg	12.3	12.3	12.3	8.7	5.3	4.3	5.0	5.3	5.3	5.3	5.3	3.7	3.7	3.7	3.7	**5.3**	**5.7**	**5.7**	**5.7**	**5.7**	**5.0**	4.3	3.3	2.0	4.0
4 km avg	10.5	10.5	10.5	10.5	7.3	5.3	5.0	5.0	5.0	5.0	4.8	4.3	4.0	4.0	4.3	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**	**5.3**	4.8	3.8	3.0	3.0
5 km avg	9.0	9.0	9.0	9.0	9.0	6.8	5.0	5.0	5.0	5.0	4.6	4.6	4.6	4.2	4.6	**5.4**	**5.4**	**5.4**	**5.4**	**5.4**	**5.2**	**5.0**	4.2	3.0	3.0

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
avg	3.0	7.0	0.0	3.0	2.0	9.0	2.0	4.0	2.0	4.0	5.0	4.0	4.0	2.0	2.0	0.0	2.0	3.0	2.0	5.0	3.0	6.0	3.0	12.0	1.0
avg	5.0	5.0	3.5	2.5	5.5	5.5	5.5	3.0	3.0	4.5	4.5	4.5	4.0	3.0	2.0	1.0	2.5	2.5	3.5	4.0	4.5	4.5	**7.5**	**7.5**	6.5
avg	4.0	4.0	3.3	4.7	4.7	5.0	5.0	5.0	3.7	4.3	4.3	4.3	4.3	3.3	2.7	1.7	2.3	3.3	3.3	4.7	4.7	**7.0**	**7.0**	**7.0**	5.3
avg	3.3	3.3	3.5	4.0	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	3.8	3.0	2.0	3.0	3.3	4.0	4.3	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
avg	3.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	3.8	3.8	3.8	3.8	3.4	2.4	3.0	3.8	3.8	**5.8**	**5.8**	**5.8**	**5.8**	**5.8**	**5.6**

	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
avg	2.0	5.0	**8.0**	3.0	7.0	4.0	6.0	3.0	4.0	3.0	**8.0**	**9.0**	5.0	5.0	3.0	2.0	5.0	5.0	1.0	0.0	2.0	2.0	4.0	4.0	8.0
avg	3.5	**6.5**	**6.5**	5.5	5.5	5.5	5.0	4.5	3.5	5.5	**8.5**	**8.5**	7.0	5.0	4.0	3.5	5.0	5.0	3.0	1.0	2.0	3.0	4.0	6.0	6.0
avg	5.0	**5.3**	**6.0**	**6.0**	**6.0**	**5.7**	**5.7**	4.3	5.0	**6.7**	**7.3**	**7.3**	**7.3**	**6.3**	4.3	4.0	4.0	4.0	3.7	2.0	2.7	3.3	5.3	5.3	5.3
avg	5.0	**5.8**	**5.8**	**5.8**	**5.8**	**5.5**	5.0	5.0	**6.0**	**6.3**	**6.8**	**6.8**	**6.8**	**6.8**	5.5	3.8	3.8	3.8	3.3	2.8	3.0	4.5	4.8	4.8	4.8
avg	**5.6**	**5.6**	**5.6**	**5.6**	**5.6**	**5.6**	**5.6**	**5.4**	**5.8**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	4.8	4.0	4.0	3.2	2.6	4.0	4.2	4.6	4.6	4.6

High Crash segments: 0 km to 3 km, 9km, 27 km, 31 km, 49 km, 53 km, 61 to 62 km, 75 km

Accident Distribution Along the Chainage 76-100

	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1 km avg	3.0	4.0	4.0	3.0	5.0	8.0	4.0	3.0	2.0	5.0	3.0	7.0	5.0	1.0	6.0	2.0	1.0	5.0	0.0	3.0	4.0	0.0	5.0	0.0	3.0
2 km avg	5.5	4.0	4.0	4.0	6.5	6.5	6.0	3.5	3.5	4.0	5.0	6.0	6.0	3.5	4.0	4.0	3.0	3.0	2.5	3.5	3.5	2.5	2.5	2.5	3.0
3 km avg	5.0	5.0	4.0	5.3	5.7	5.7	5.7	5.0	3.3	5.0	5.0	5.0	5.0	4.3	4.0	3.0	3.0	2.7	2.7	2.7	3.0	3.0	3.0	2.7	2.7
4 km avg	4.8	4.8	5.0	5.0	5.0	5.0	5.0	5.0	4.3	5.0	5.0	5.0	5.0	4.8	4.8	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	2.8	3.0
5 km avg	4.6	4.8	4.8	4.8	4.8	4.8	4.8	4.6	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.2	3.0	3.0	2.8	2.6	2.6	2.4	2.6	2.6	3.2

	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
1 km avg	3.0	2.0	4.0	4.0	1.0	3.0	3.0	3.0	6.0	4.0	4.0	1.0	1.0	6.0	1.0	3.0	6.0	2.0	0.0	0.0	2.0	3.0	7.0	3.0	3.0
2 km avg	3.0	3.0	4.0	4.0	2.5	3.0	3.0	4.5	5.0	5.0	4.0	2.5	3.5	3.5	3.5	4.5	4.5	4.0	1.0	1.0	2.5	5.0	5.0	5.0	3.0
3 km avg	3.0	3.3	3.3	3.3	3.0	3.0	4.0	4.3	4.7	4.7	4.7	3.0	2.7	3.3	3.3	3.7	3.7	3.7	2.7	1.7	4.0	4.3	4.3	4.3	4.3
4 km avg	3.3	3.3	3.3	3.3	3.0	3.8	4.0	4.3	4.3	4.3	4.3	3.8	3.0	4.0	4.0	4.0	4.0	3.0	2.8	3.0	3.8	4.0	4.0	4.0	4.0
5 km avg	3.2	3.2	3.2	3.2	3.2	3.8	4.0	4.0	4.0	4.0	4.0	3.6	3.4	3.6	3.6	3.6	3.6	3.6	2.4	3.0	3.6	3.6	3.6	3.6	3.6

High Crash segments: 81 km, 87 km, 90 km, 109 km, 114 km, 123 km

Inferences from Crash Data Analysis

- Crashes based on types of collision

Type of Crash Collision	Fatal Crashes (%)	Non-Fatal Crashes (%)
Rear End	41%	33%
Hit Median	12%	18%
Hit Guardrail + Overturned+ Topple Down	11%	26%
Total (%)	64%	77%

- Crashes are distributed all over.
- **Average Rate: 3.39 Accident per km**
- Identification of **crashes locations** based on hotspot analysis

0 to 3 km, 9km, 27km, 31 km, 49 km, 53 km, 61 to 62 km, 75 km, 81 km, 87 km, 90 km, 114 km, 123 km, 165 km

- Exit and Entry Ramps are unsafe.

SITE INVESTIGATION

1) **Site Visit** : Investigating team to make thorough inspection of the blackspot site where road crashes have occurred. The two main reasons for doing the site inspection are-

i) to accurately assess the road conditions and other site factors which may be relevant; and

ii) to actually experience the problems that road users are facing.

Ideally, the engineering investigating team should walk as well as drive through the site in both day and night-time conditions.

2) **Recording of Findings** :

- Video cameras, or digital cameras and voice recorders, enable images of the site to be recorded along with a spoken commentary of issues.
- Following safety protocol shall be followed for all site visits: Ensure personal safety / team safety, Ensure public safety.

3) **Site Investigation Form (Checklists)**:

- Investigation team shall use site investigation form these may include the typical aspects like obstructions to the visibility, lack of visual clues, uncontrolled junction maneuvering, visibility triangle (in the case of intersections and curves) and lack of pedestrian facilities, etc.

CHECKLISTS

3 Types of Checklists

1.Checklist for Entry, Exit Ramps and Interchanges

2.Checklist for linear sections

3.Checklist for toll plazas

Checklist for Entry/Exit, and Interchanges

Divided into 5 Sections

- **Section 1**: General Items
- **Section 2**: Check for Signs
- **Section 3**: Traffic Calming Measures
- **Section 4**: Check for Guardrail
- **Section 5:** Lighting Condition

Checklist Exit and Entry Ramp, Interchanges

Checklist for Exit/Entry Ramps and Interchanges

Objective						
Road Name						
From				To		
Facility Type	Entry			Exit		
Facility Number						
Chainage						
GPS Location	Lat			Long		
Section	LHS			RHS		
Auditor Name						
Contact No.						
Date						
Time				Weather		

1. Will road users coming from all directions be able to see that they are approaching a conflict area?

Item(s)	Availability	Width	Colour	Visibility	Retro-Reflectiveness	Photo Reference (Time)
Give-way Lines						
Directional Markings						
Stop Lines on Minor Road						
Accelerating Lane						
Decelerating Lane						
Crash Cushion (s)						
Chevron Markings						
Informatory Sign						
Any Other Observation						
Any Road Safety Hazard / Objects						

2. Check for Signs

Sign type	Availability	Standard Conformity					Any Obstruction to Sign	Photo Reference (Time)
		Shape	Colour	Retro Reflectiveness	Placement	Height		
No Entry								
Give Way								

Contd...

Merging Traffic Ahead (at least 180m ahead)								
Exit Sign								
Advance warning Signs								
Map type and Stack type direction sign (on Exit)								
Entry Sign (on the Minor road)								

3. Traffic Calming Measures

Check on		**Yes/No**	**Remarks**
1	Rumble Strips		
2	Speed Cushions		
3	Speed Tables / Table-top		
4	Deceleration Lanes		
5	Acceleration Lanes		
6	Lane Width Restrictions (at Exit)		
7	Road Stud/Cat's Eye		
8	Guardrail		
Any Other Measure			

4. Crash Barriers

Type	W-Beam		Cable		New-Jersey		Others	
Height (mm)								
Retro Reflective Markings								
Any Other Observation(s)								

5. Lighting Conditions

Illumination	
Spacing of Light Poles	
Unprotected Lighting Poles	
Other Observations	

Checklist for Linear Section

- Checklist divided into 10 sections
  - **Section 1:** Check of Pavement Markings as per RIC 35-2015
  - **Section 2:** Check for Road Signs IRC 67-2012
  - **Section 3:** Check of Median Type and Design
  - **Section 4:** Check for Road Side Barrier/Crash Barriers
  - **Section 5:** Check on Shoulder Type and Design
  - **Section 6:** Check on Lighting Conditions
  - **Section 7:** Plantations (on median side)
  - **Section 8:** Truck Lay Byes
  - **Section 9:** Roadside Environment (Outside the crash barrier or below the embankment)
  - **Section 10:** Overall Observation of the Audited Location or Section

Checklist for Linear Section

Checklist for Linear Section

Objective				
Road Name				
Chainage				
Traffic Flow Direction	From		To	
GPS Location	Lat		Long	
Auditor Name				
Contact No.				
Date				
Time				

1. Check of Pavement Markings as per RIC 35-2015

Items	**Line Colour** (Yes =0; No = 1)	**Line Type** (Yes =0; No = 1)	**Width**	**Visibility**	**Retro-Reflectiveness**	**Continuity**	**Photo Ref (time)**
			(Yes =0; No = 1)				
Edge Border							
Centre Line							
Traffic Lane Line							
Warning Line							
Overtaking Line							
Directional Arrows							
Other Markings							

Contd...

Other Observation (s)						
2. Check for Road Signs IRC 67-2012						
Sign Type	Mandatory		Cautionary		Informatory	
Availability						
Shape						
Colour						
Retro-Reflectiveness						
Longitudinal Placement						
Height						
Any Obstruction to Sign						
Photo Reference (Time)						
3. Check of Median Type and Design						
Type of Median	Flushed		Raised		Others	
Height (If Raised) in mm						
Width (m)						
Presence of Guard Rail						
Plantation						
Opening						
Frequency of Opening (per/km)						
Type of Hazards	Tree		Poles		Others	
Protection of Hazard						

Check List for Toll Plaza

Checklist divided into 5 sections

- **Section 1:** Traffic Sings
- **Section 2:** Markings
- **Section 3:** Speed reduction measures
- **Section 4:** Measures to curb last minute changes
- **Section 5:** Lighting

Check List for Toll Plaza

CHECKLIST FOR TOLL PLAZA

Objective					
Road Name					
Chainage					
Direction	From		To		
Section	LHS		RHS		
GPS Location	Lat		Long		
Auditor Name					
Contact No.					
Date					
Time			**Weather**		
Item	**Check**			**Yes/No**	**Remarks**
Traffic Signs	Gantry Sign 1 km before toll plaza starts?				
	Gantry Sign 500m before toll plaza starts?				
	Is the condition of Gantry Signs is good?				
	Is the placements of the sign are adequate according to IRC standards?				
	Is stop sign marked on the pavement at the toll lanes?				
	Signs for indicating toll prices for different vehicle categories?				
	Electronic signs installed over toll booth to display operation status?				
Markings	Are Lane markings visible? (Including Edge line and centerline markings)				
	Is Lane separation proper?				
	Are dimensions of markings as per standard?				
Speed Reduction	Are rumble strips have been provided?				
	Speed Breaker? (After few rumble Strips) with studs and sign				

Contd...

Measures	Use of Transverse Pavement Markings to Reduce Speeding		
	Speed limits posted at each lane?		
	Speed limit painted on the pavement in advance of the plaza?		
	Are regulatory speed limit signs have been installed?		
	Digital signs displaying real-time speeds at the plaza?		
Measures to Curb Last Minute Lane Change	Channelization of Traffic		
	Longitudinal markings further upstream of the toll plaza to assist with lane delineation.		
	Buffer lane between the ETC lanes and cash or mixed-use lanes		
	High-visibility flexible delineators to separate traffic at plazas		
	Use physical barriers to separate approaching high speed traffic from cash or mixed lanes.		
Lightings	Can Toll plaza be seen from an adequate distance?		
	Highway lighting (100m) length provided on both sides of the toll plaza?		
	Is canopy lighting installed?		
	High Mast Lighting of 30 Lux recommendable of 30m height is installed?		
	Are road studs installed to enhance the visibility?		
	Is the visibility of toll plaza at night adequate?		

Pavement Markings

- Only Edge Border and Traffic Lane line are present throughout the expressway
- Warning lines, directional arrows and other markings are missing throughout

- Refer to **IRC – 35- 2015 section 3 and 4** for detailed guidelines on road markings

Road Signs

- Only Informatory and Advertisement signs are present
- Wrong Placement of sign post on the shoulder itself without any protection

- Refer to **IRC – 67-2012 section 3,4,14,15** for guidelines on road signs

Median Type and Design

- Median is raised 200mm from the ground and 6m wide
- Raised medians are hazardous leading to accidents
- Trees, small structures, gantry sign poles and solar panels are on the median

- **IRC – SP-99-2013 section 2.5** does not allow for raised median

Crash Barriers

- Steel W beam is present throughout the length of the road.
- The measured height is between 0.55m to 0.70m.
- Retro-reflective marking is missing on the guardrail.
- Distance from carriageway edge is 7.5m and distance from hazard is 1.5m

4) **Additional Surveys and Studies** :

- Detailed examination of witness statements in the Police case file.
- Traffic counts and surveys of classified turning volume counts at junctions
- Pedestrian counts
- Surveys of pedestrian crossing behaviour
- Measurement of visibility distances
- Spot speed surveys
- Conflict studies

FINAL DIAGNOSIS & DEVELOPMENT OF COUNTERMEASURES

1. **Final Diagnosis** : Investigation team is expected to come out with diagnosed problems for each of the blackspot site. The findings have to be drawn and clearly expressed with sound reasoning, because these are the basis for selecting the countermeasures.

2. **Identify Treatable Problems** : The analysis should always yield results with two types of locations such as –
    - Locations where distinct problems are identified
    - Locations where the analysis are inconclusive

3. **Countermeasures** : Certain engineering treatments, if implemented properly, are very successful in reducing certain common crash types. These engineering treatments are generally known as countermeasures. Likely contributory factors along with potential countermeasures are given below :

Likely Contributory Factors		Possible Countermeasures
Excessive speed not matching the road environment.	Speed limiting measures	Install vertical speed calming measures – speed breakers etc.
Driver fatigue		Provide speed limiting signs and initiate speed enforcement.
Road alignment unclear		Install warning signs along with advisory speed limit.
Excessive speeds- loss of control	Improve control	Mark no overtaking zones and initiate speed enforcement.

IMPLEMENTATION OF BLACKSPOT MITIGATION MEASURES

The formulation of mitigation scheme has benefits such as :

i. Enable safety engineer to check mitigation measures suitability at the site and there will not be any conflicts or other problems.

ii. Client will have better understanding of the mitigation proposals and subsequently make provision for budgeting, approvals, etc.

iii. Enable bidders to better understand and thus give a realistic quote.

iv. Provide a basis for controlling the construction work on site.

DETAILED DESIGN OF BLACKSPOT MITIGATION MEASURES :

- The detailed design may involve topographic surveys, traffic studies, soil and geotechnical surveys, geometric design, structural design, intersection designs, road signs, road delineators and pavement marking proposals, estimation of quantities and costing, cost benefit analysis and preparation of bid documents.

- **IMPLEMENTATION :** mitigation measures can be implemented as part of the routine maintenance in case of short term measures or as an independent work for long term measures.

- **SCHEME IMPLEMENTATION RECORD:** The implementation record shall have site investigation report, crash details, built drawings and actual cost of implementation.

MONITORING & EVALUATION

- **Initial observations** : It is expected that road users will take some time to get used to new traffic schemes and junction improvements, and a few crashes may happen during this time.
- **“Before" and “After" studies** : The basic method of measuring the effect of a scheme is to compare the situation before it was implemented with that after it was implemented.
- **Short-term measures of performance** : "before" and "after" will give an indication of whether safety at the site has improved
- **Statistical tests** : most commonly-used are - Tanner k test , Chi-squared test. Both these tests involve comparing before and after data from the treated site with before and after data from similar but untreated sites, known as *control sites.*

Thanks!