iRAP as an approach for safety assessment of "Anand-Mahal-Rander Road" of Surat City

[1]Lotwala Vidish Pankajkumar,[2]Bhasker Vijaykumar Bhatt
[1]P.G. Student, Town & Country Planning II,
[2]Former PG in-charge (ME-TCP) & Assistant Professor Faculty of Civil Engineering, Sarvajanik College of Engineering and Technology, Surat, Gujarat, India

Abstract: ***Globally, people are using roads for different purposes daily. With the usage of roads, the road encounters several problems resulting in a variety of problems for the road users. A significant point of concern is proper crashes & fatalities. India has a wide network of roads that have a variety of hierarchy and categories. Surat is one of the fastest developing cities in the world. The aim of the proposed study is to identify a road and analyze it using iRAP based parameters & methodology. The study area proposed here is the West Zone of Surat where the study ranking for different aspects involved, a suitable proposal for improvement will be worked out with alternatives. Surat is a city located in the western part of India in the state of Gujarat. The pattern of roads is radial,and the main artery runs along the fort wall in the Northeast to Southwest direction, joining National Highway No. 8 at a distance 16 KM from Surat. The paper discusses about road crashes on the selected study stretch. Also, the results of star rating obtained using iRAP methodology using tool are discussed.***

Index Terms: iRAP, Road accidents, Road assessment, Road safety, VRU, West Zone.

I. INTRODUCTION

Roads knit people, communities and market together. It is the lifeblood of cities and regions. More than any other mode of transportation, roads remain the predominant and universal transport network - but it is also the deadliest. The current rates of road fatalities are of epidemic proportions, and have disastrous consequences for affected families, communities and societies. The economic cost of serious road crashes is estimated to be up to 10% of gross domestic product in some countries. Road is an essential element of modern society, helps transport of person and goods. At the same time such transport carries one of the highest risks of accidents. Safety is therefore very important aspect of road planning.

Road transport can and ought to be secure, not for those using vehicles, but for everyone at every stage of life – from young children through to the elderly. Providing a safe, low-risk transport system is a crucial step towards achieving social and economic health and the prosperity. The United Nations Sustainable Development Goals set the challenge of halving the number of global deaths and injuries from road traffic crashes by the year 2020.

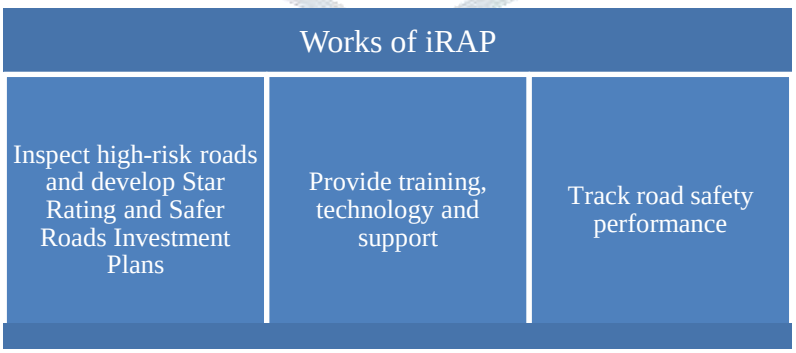
Direct, simple comparison of the relative safety of roads, between India and other countries of the world, is difficult owing to several factors;

- Differing levels of the quality of data recorded;
- Availability of standard measure and data reflecting exposure of road users to risk.

In order to focus the attention of central and local authorities on road safety, many industrialized, decreased fatalities, detention of problems using a collection of data and data analysis.

II. CONCEPT OF IRAP

The International Road Assessment Programme (iRAP) is a registered charity dedicated to saving live through safer roads.



The iRAP has drawn upon the extensive knowledge base of established RAP (EuroRAP, AusRAP and usRAP), with thegenerous support of the FIA foundation, Global Road Safety Fatality and the Road Safety Fund, to target high-risk roads where large numbers of people are killed and seriously injured and inspect then to identify where affordable programmes of safety engineering can reduce death and injury.

Regional development banks, national governments, automobile clubs and associations, charities, the motor industry and institutions such as the European Commission also support RAPs and encourage the transfer of research and technology to iRAP.

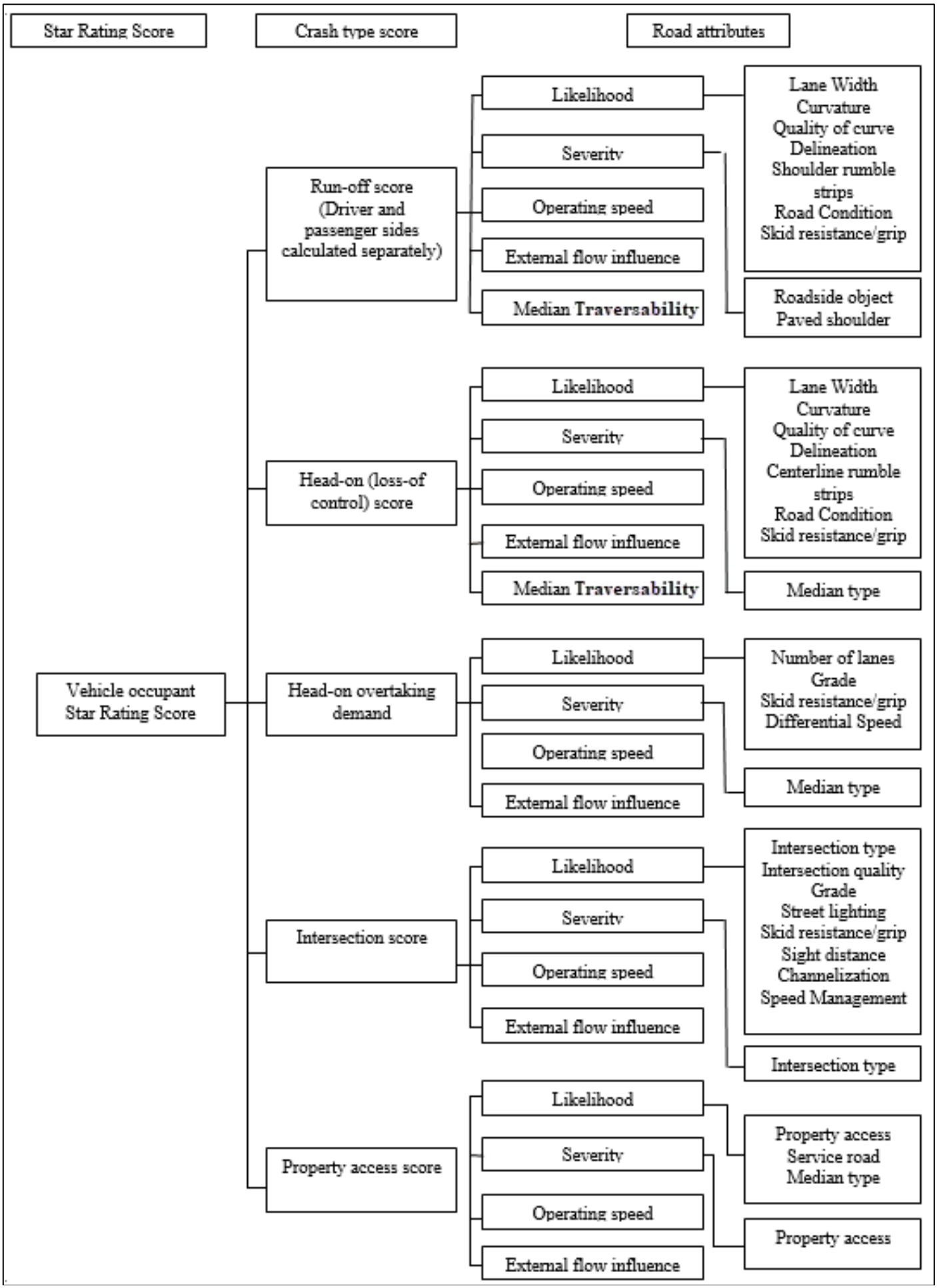


Figure 1Parameters used in iRAP process

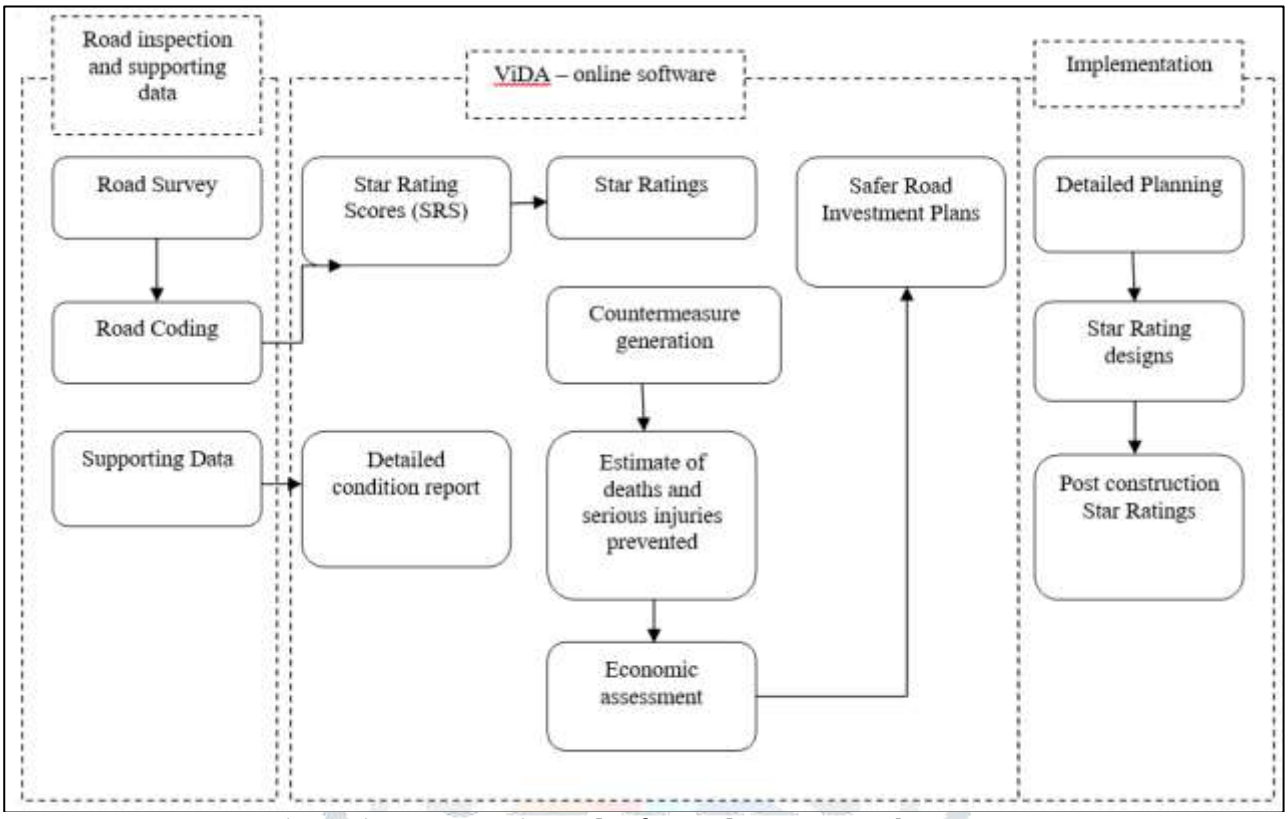
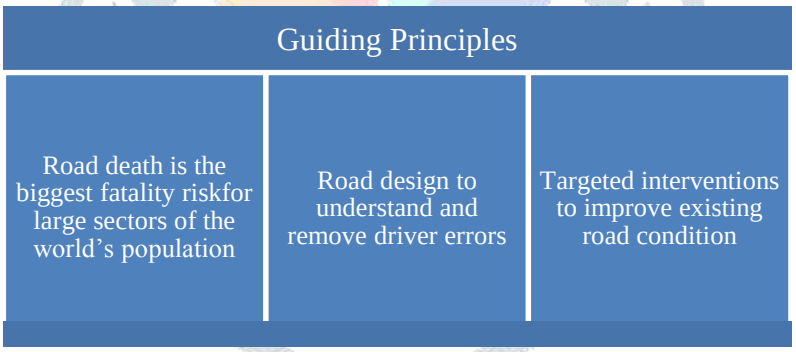


Figure 2iRAP Star Rating and Safer Roads Investment Plan process

Different Donors and partners involved with iRAP.

a) ProgrammeDoners- FIA Foundation, Road Safety Fund, Global Road Safety Facility.
b) Development Partners- ADB, CAF, European Bank, IDB, The World Bank, FIA.
c) Centres of Excellence- IMT, SWOV, ARRB group, MRI global, KOTI



III. METHODOLOGY

3.1 Road Survey and Coding

Using a specially equipped vehicle or high-resolution camera the road network was surveyed, recording digital images at 100m intervals to enable the coding of road attributes relating to the likelihood and severity of a crash.

Road Survey

The features of the inspection system were:

- Use of three high-resolution digital cameras (1280 x 960 pixels).
- Digital images collected with a 150 to 180-degree field of view (centred on the travel lane) at 100m intervals.
- Geo-reference data was collected for each digital image, including distance along the road (from an established start point) plus latitude and longitude coordinates.

The images were calibrated to enable detailed measurements of the road features.

It had the capability to provide automated measurements of radius of curvature for horizontal curves and gradient for vertical alignment.

Pavement condition data was also collected via a digital laser-based profiler beam fitted to the front of the vehicle. Each system was fully integrated, and the outputs linked to both spatial (GPS) and linear references. The pavement condition data will be made available to asset management engineers in each state.

iRAP Coding

Upon completion of the road survey, the digital images and geo-referenced data was coded from each of the interval using Hawkeye Processing Toolkit software, in accordance with the iRAP Coding Manual. The coded data were subject to quality assurance checks in accordance with iRAP's Rating Quality Assurance Guide, prior to any analysis occurring.

Road attributes

There are many road attributes which carried out for the study which have different perspective which is as follows:

Vehicle per day Motorcycle flow (% of traffic)

Bicycle flow
Pedestrian flow along the road
Number of lanes
Road condition
Side friction
Pedestrian crossing facilities
Bicycle facilities
Speed
Paved shoulder width
Curvature
Overtaking demand
Sidewalk provision (both sides)
Roadside severity (both sides)
Intersection type
Pedestrian flow across the road
Area type
One/two-way flow
Land used (both side)
Shoulder rumble strips
Pedestrian crossing quality
Motorcycle facilities
Lane width
Unpaved shoulder width
Quality of curve
Delineation
Access point density
Median type
Intersection quality

3.2 Supporting data

Although the iRAP Star Ratings and Safer Roads Investment Plans use a standardized global methodology, the models are calibrated with local data to ensure that the results reflect local conditions.

Role of speed

The issue of speed management is of paramount importance in road safety.

The risk of death or serious injury is minimized in any crash, where:

- Vulnerable road users (e.g. motorcyclists, bicyclists and pedestrians) are physically separated from cars and heavier vehicles, or traffic speeds are 40km/h or less;
- Opposing traffic is physically separated,and roadside hazards such as trees and other fixed objects (including concrete guard posts) are well managed;
- Traffic speeds are 70km/h or less for occupants of cars on roads where opposing traffic flows are not physically separated or where roadside hazards exist.

Speed data

For much of the surveyed network, a clearly defined speed limit was difficult to detect. Where speed limit signs were observed, vehicle speeds were often well in excess of the posted limit.

The method adopted to estimate 85th percentile operating speeds and the assumptions made are detailed below:

- Vehicle operating speeds were based on the data collected within that study;
- Elsewhere (based on the findings of the speed surveys), vehicle speeds were assumed to be 80km/h in rural areas, except where pavement condition was poor and narrow lanes were recorded, in which case 70km/h speeds were used in the analysis;
- In semi-urban areas vehicle speeds were assumed to be 60km/h;
- In urban areas, vehicles speeds were assumed to be 50km/h or less.

Traffic Volumes

Total traffic flow (or volume) for all motorized vehicles is required for each road section and is used in the estimation of the distribution of the numbers of deaths and serious injuries that could be prevented on the network. The data is required to be in Annual Average Daily Traffic (AADT) format and should not be adjusted to passenger car equivalent (PCU) volumes.

Motorcycle volumes

Detailed data on motorcycle traffic was not available for all roads included in the assessment. Where available, data from detailed traffic surveys were used, for other roads estimates have been made based on other data source.

Pedestrian and bicycle volumes

Pedestrian and bicycle flows were recorded during the coding process. It is possible to rely solely on this data for processing, though it is not recommended.

Number of deaths and serious injuries

As part of the iRAP model calibration, an estimate of the number of deaths and serious injuries that occur on the road was required. In order to allocate deaths and serious injuries to the network, the iRAP model requires an estimate of the distribution of deaths by road user type.

The economic cost of death and serious injury

The key equations used are:

- The economic cost of death is estimated to be: 70 x GDP per capita;
- The economic cost of a serious injury is estimated to be: 0.25 x economic cost of the death.

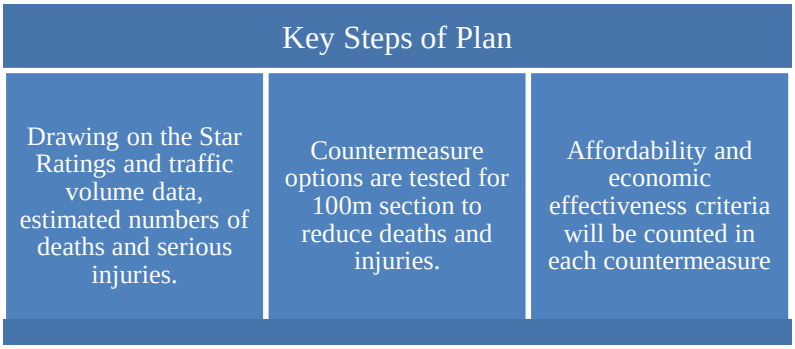
3.3 Star ratings

iRAP Star Ratings are based on numerous road features and the degree to which they impact the likelihood and severity of road crashes. The focus is on the features which influence the most common and severe types of the crash on roads for motor vehicles, motorcyclists, pedestrians and bicyclists. 5-star (green) roads are the safest, while 1-star (black) roads are the least safe. Star Ratings were not assigned to roads where there was deficient use by that type of road user. For example, if no bicyclists use a section of road, then a bicyclist Star Rating is not assigned to it.

The Star Ratings are based on Road Protection Scores (RPS). The iRAP models calculate an RPS at 100-metre intervals for each of the four road user types, based on relative risk factors for each of the road attributes.

IV. SAFER ROAD PLANS

iRAP considers road improvement options to generate affordable and economically sound Safer Road Investment Plans that will save lives. Road improvement options range from low-cost road markings and pedestrian refuges to higher-cost intersection upgrades and full highway duplication.



V. DATA COLLECTION

In India, there are many accidents occurs in a tremendous amount. In which road accidents occur in high range and % from total accidents. It also affects the GDP of Indiaand also affects the family of people whose accidents are occurred. There are many states in India whose road accidents numbers are more than 25000 and more than half states have 10000 plus accidents numbers in every year.

Table 1Highest accidents occurred states in India

Sr. No.	State	Road accidents		
		2014	2015	% variable
1	Andhra Pradesh	23154	22839	-1.4
2	Gujarat	22152	23362	5.5
3	Karnataka	43694	44011	0.7
4	Kerala	35872	39014	8.8
5	Madhya Pradesh	39698	40859	2.9
6	Maharashtra	44382	42250	-4.8
7	Rajasthan	24639	24072	-2.3
8	Tamil Nadu	67250	69059	2.7
9	Telangana	20078	21252	5.8
10	Uttar Pradesh	26064	28095	7.8
				3.0

(Source: Accidental Deaths & Suicides in India, NCRB)

Table 2Four city accidents scenario of Gujarat

Sr. No.	City	Road accidents		
		2014	2015	% variable
1	Ahmedabad	1906	2022	6.1
2	Rajkot	770	780	1.3
3	Surat	882	903	2.4
4	Vadodara	1161	1164	0.3

(Source: Accidental Deaths & Suicides in India, NCRB)

Preliminary data collection

In the primary data, there is accident data which is carried out in police stations of that area. In the West Zone, there are two police stations which coversentire spatial area of the zone.

The accident data which is collected from police stations are as below:

Table 3 Road Crash Events of Rander Police Station (2011-2017)

Rander Police Station									
Year	2011	2012	2013	2014	2015	2016	2017	Total	Average
Fatal	18	14	4	9	12	7	9	73	10
Serious	27	31	32	24	23	14	19	170	24
Minor	16	16	10	14	9	9	7	81	12
Total	61	61	46	47	44	30	35	324	46

(Source: Rander Police Station)

Rander and Adajan Police Stations are the main in West Zone area which is recorded in the crime section. The data were taken between the year 2011 to 2017 in which there are mainly 3 types of accidents,i.e. fatal, serious and minor.

In the Rander Police Station, there is total 324 accident recorded in which 73 accidents are recorded as fatal, 170 accidents are as serious,and 81 accidents are recorded as minor accidents.

In the Adajan Police Station, there is total 218 accident recorded in which 49 accidents are recorded as fatal, 117 accidents are as serious,and 52 accidents are recorded as minor accidents.

Table 4Road Crash Events of Adajan Police Station (2011-2017)

Adajan Police Station									
Year	2011	2012	2013	2014	2015	2016	2017	Total	Average
Fatal	7	9	3	4	7	11	8	49	7
Serious	17	18	21	15	11	18	17	117	17

Minor	2	13	17	8	6	1	5	52	7
Total	26	40	41	27	24	30	30	218	31

(Source: Adajan Police Station)

So, there is total 542 accident recorded in West Zone in which 122 accidents are recorded as fatal, 287 accidents are as serious,and 133 accidents are recorded as minor accidents. So, total 77 average accidents occurred in West Zone each year.

Table 4Road Crash Events of West Zone (2011-2017)

Total (West Zone)									
Year	2011	2012	2013	2014	2015	2016	2017	Total	Average
Fatal	25	23	7	13	19	18	17	122	17
Serious	44	49	53	39	34	32	36	287	41
Minor	18	29	27	22	15	10	12	133	19
Total	87	101	87	74	68	60	65	542	77

(Source: Rander and AdajanPolice Stations)

Current Road Condition

Road condition is needed suitable for any roads on which there are many vehicles passes through the year. On my study, the road condition is carried out by road survey with taking a photograph of the current road. In the survey, there is road divided into 100 M stretch. The study results out 19 sections which are carried out with 19 observation point. On each point, there isa photograph taken with the different angles.

Black Spot

On the Anand Mahal Rander Road, there is the 8 black spots are identified as per the accidents data. The spots are mentioned as a blue circle in the photo.

Figure 3Road crashes spots on study stretch

VI. STAR RATING ANALYSIS USING IRAP ON THE STUDY STRETCH

As discussed in the previous sub-sections, the study stretch was considered for recording observations as per method suggested by the iRAP. About 19 cross-sections were thoroughly studied and information on 27 parameters were extracted. The same was fed to the tool developed the iRAP and star-rating was obtained for these cross-sections. Each cross-section was at a uniform interval of 100mt from each other making a total length of 1.8km road assessed for safety parameters. This safety assessment was focusing on major four category of road users – pedestrian, bicyclist, vehicles and motorcycles. The assessment was carried out for the aspects of traffic flow and presence of possible conflicting elements, intersection approach and geometry along with operation modes, mid-block features, road side features, speed of vehicles and presence of vulnerable road users, facilities along the roadside, land use around the study stretch. The results of analysis are shown in table below.

Table 5iRAP Star rating for study sections

	iRAP Star Ratings			
Chainage	Vehicle	Motorcycle	Pedestrian	Bicycle
200	3	3	0	0
300	2	2	0	5
400	3	3	0	0
500	3	3	0	0
600	3	2	0	0
700	2	2	0	0
800	3	3	0	0

900	3	3	0	0
1000	3	3	0	0
1100	3	2	0	0
1200	1	1	0	0
1300	3	3	0	0
1400	3	3	0	0
1500	3	3	0	0
1600	3	3	0	0
1700	2	2	0	0
1800	1	1	0	0
1900	2	1	0	0
2000	2	1	0	0

From the table above, the understanding developed is suggesting that the features of road are supporting partially for the safety of the road user of vehicle and motorcycle categories. However, the safety in terms of star rating was found to be almost zero for the vulnerable road users i.e. pedestrians and bicyclists. It suggests that there is a considerable scope for improvement of the road geometry as well as road features giving priority to the VRUs.

VII. CONCLUDINGREMARKS

Roads are vital for any livable human in the World. In the Town Planning Schemes, the roads need enough space for the transportation process for any type of work. Roads are directly or indirectly affect the GDP of the related country and economy of the people. Also, the accidents and especially fatal crashes are increasing year by year due to many problems like conjunction, traffic problems, rough driving and so many others. Road safety for all people is very important for their families also as it connects with the income of that person.

iRAP is the organization which is work related to the road safety in globally. So, that with the help of the organization road improvement is mainly focused on the study. A literature review is based on the road safety, road assessment and road accidents. The study is on the Surat city and especially on the roads of West Zone which increase in population and density in high rate. West Zone has highest accidents number as compared to other zones. The road survey, attribute survey,andiRAP coding isthe primary process which in the study.

ACKNOWLEDGEMENT

The authors are expressing appreciation for the knowledge sharing support Mr. Jigesh Bhavsar, Technical Manager, IndiaRAP and Dr Pratima A. Patel, Head, Civil Engineering, Sarvajanik College of Engineering & Technology, Surat for great motivation. Also, thanks to police inspector Satish. Crime department of Rander Police Station and Babubhai, Crime department of Adajan Police Station. Especially thanks are express to all faculty members of Town and Country planning department of Sarvajanik College of Engineering and Technology.

REFERENCES

[1] iRAP India the Four States Road Safety Report, December 2011, Luke Rogers, Senior Road Safety Engineer, Asia Pacific
[2] Global Status Report on Road Safety 2015, WHO
[3] Accidental Deaths & Suicides in India, 2015, NCRB, Ministry of Home Affairs, Government of India
[4] Utsav t. Patel (2012). Planning proposal of road infrastructure development for the south zone of Surat city
[5] Police Stations of West Zone of Surat City