Mitigation Of Black-Spot's on Highways by The Application of Safe System Approach

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ABSTRACT

With increase in traffic volume across the globe traffic safety has come into highlight and become a major concern. Apparently, with due increase in traffic volume resulting in higher road accidents which considerably causes negative impact on economic growth, public health and general welfare of wellbeing. In the present scenario challenges are faced to mitigate the traffic volume and by making road users aware with road safety parameters which may results in less road fatalities. The root cause of an accidents intends to perception, intellection emotion and violation. The approach towards this research is to get minimal setback/casualties of the road. In order to gain the best possible course of action, the stretch of 8 KM of National highway (NH-66) situated in a plain terrain in the district of Alapphuza, Kerala India. To begin with, accident data has been collected from NHAI office and Police station of above location with proper analysis by Accident Severity Index (ASI) method has been carried out. Adding to an idea, location of Black Spot has been identified by ASI method. Based on Severity of accident short term and long-term measures has been adopted. Eventually, after analyzing short term measures 10 black spot location along with the estimate has been worked out.

Keywords : Accident Severity Index, Black-Spots, NHAI, Road Safety Parameters.

I. INTRODUCTION

India has second highest population in the world so it requires a substantial transportation services like air, land and water transportation. Road transportation is the only means of transportation which has keen insight in all areas and responsible for door-to-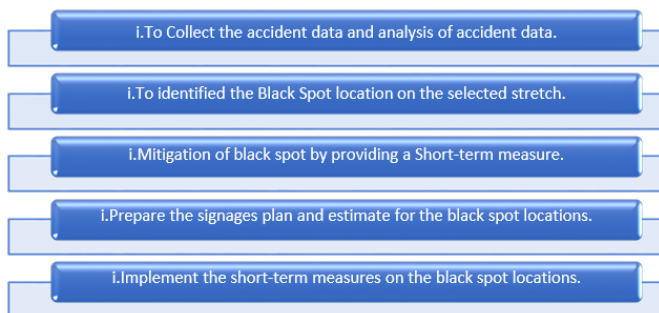door service. Hence it is extremely important to enhance and sustain the road network of our country. But on the other hand, with increase in population the number of vehicles is also increasing which are responsible for occurrence of a greater number of accidents. This causes an obstruction for the economic and social growth of the country.

According to World Health Organization (WHO) road accidents are the leading cause of death amongst people aged in between 15-29. Applications of safety measures are not economical, but overall result has profitable, but limited funds put restrictions on the number of sites that may be treated. Therefore, it is necessary to pinpoint the high-risk stretches on the Highway and provide safety measures on those stretches on a priority   in order to utilize the limited fund as effectively as possible.

According to MORT&H "Black spot is a stretch on a Highway of about 500m in Length in which either 5 road accidents (in all three years put together involving [fatalities grievous injuries) took place during the Last 3 years or 10 fatalities (in all three years put together) took place during the Last 3 years."

II. OBJECTIVES

The main objective of this research is:

i. To Collect the accident data and analysis of accident data.

i. To identified the Black Spot location on the selected stretch.

i. Mitigation of black spot by providing a Short-term measure.

i. Prepare the signages plan and estimate for the black spot locations.

i. Implement the short-term measures on the black spot locations.

III. LITERATURE REVIEW

Relevant work has been conducted on engineering-based counter measure development for improvement of safety performance.

Riadh et al [1] With the use of Spatial Data Analysis Method (Moran's I and Getis-Ord) Riadh et al. has recognized the computative cluster location of the road accidents "Black Spots" and the outcome validates that the Black Spots figures are higher than affirmed by public authorities i.e.,

20 Black Spots at odds with 9 Black Spots. Moreover, this method defines the actual classification of the scope. Hence, the Black Spots are codifying by their danger degree. Studies shows that Black Spot span detected by the method is less important versus the Public Authority of Road Safety (2000m vs 7000m). This implicit that it is feasible to minimize the Insecurity Cost by 71%. Furthermore, this suggested classification gives safe infrastructure in the matter of Public Expenditure need.

Chen et al. [2] by means of Geo-spatial information has recorded the traffic casualties which shows how to make use of Geo-coding technology and VRS-GPS positioning technology. Two-way association relationship is defined by Spatial relationship computation which is based on the Spatial relationship between the traffic accidents and road network elements. This paper illustrated the technique which tends to minimize accidents which leads to uproot the Black spots. Ultimately, in the analysis, the association between Black spots and Traffic attributes is used to examine the factors that caused traffic accidents.

Medury et al [3] has suggested a Dynamic programming-based Hot Spot identification approach which allows the efficient Hot Spot definitions for Pedestrian Crashes. To correlate with the proposed approach, sliding window method and Intersection buffer-based approach is taken into consideration. The outcomes shows that the Dynamic Programming method produce more Hot Spots with a higher number of Crashes, while providing small Hot Spot Segment length. Whereas, due to first-come-first serve approach the sliding window method is shown to suffer from shortcomings and vice versa, Hot Spot identification and a fixed Hot Spot window length assumption.

Ghodmare et al (2019) [4] has gone through the comparative analysis by taking BRTS and MRTS,

which are costly in terms of investment and in terms of environmental impacts, MRTS is more productive than BRTS. If Intelligent Transportation System is incorporated the service of both systems may come up with more efficiency. It can be asserted that combination of various public transportation system should be well organized through the stages of design taking into account the integrated approach as a need for convenient public transportation system.

Honnappanavar et al. (2015) [5] canvass the present state of Traffic Accidents Information on SH-85 from Tavarekee to Magadi Town in Karnataka State. They have also limelight the identification of Black Spots by using Weighted Severity Index method. For analyzing and prioritizing the black spots GIS software is used. To mitigate the Black Spots and to provide an improved traffic safety, engineering measures are also adopted.

Ghodmare et al (2019) [6] With the use of Multi Attribute Utility technique has estimated the sustainability index which is based on combination of individual performance measures for emerging metropolitan city of Nagpur. The outcome achieved is used in sustainability evaluation process for any corridor easily. For comparing the results of sustainability evaluation in different scenarios, this technique is adopted.

Nikhil et al. (2013) [7] used the idea in which the accidents were classified based on the severity of injuries. From year 2002-2011, accident data with total number of accidents for each year for Banglore city was acquired from the Banglore City Police was obtained. This accident data was compared with the Karnataka State data and accident data from Gorguntepalya and Jalahalli was studied. The classified volume count data i.e., the number of vehicles per day passing at different locations was found out plus the corrective measures for selected spots were proposed.

Mandloi et al. (2003) [8] suggested a procedure to identify the Black Spots location on roads. With the use of Geographic Information System (GIS) ARCVIEW 3.1 this procedure comprises of a model which implements prioritization of roads for accident casualties. The factors required for the analysis are grouped using Microsoft Visual Basic6.0 and Microsoft Visual C++6.0 software packages. This model is examined on the road network in BITS PILANI, henceforth, the outcomes are examined/analyzed to get the most accurate data for the model.

Apparao et al. [9] talked through the present state of traffic accident information on NH-58 from Meerut to Muzaffarnagr in Uttarakhad State. It also focuses on identification of High-Rate accident location by GIS Software and safety deficient areas on the highway. Thus, considerable course of action should be taken on Black Spots and traffic safety provisions should be adopted.

Metre et al (2021) [10] has investigated the Nagpur city in India in the context of compact city. The development concept is theoretical elements of the compact city. It attempts to examine the physiological aspects. The compactness of cities mostly relates to urban sustainability achieved by dense, mixed neighborhoods which makes the city more livable. Presently the developing cities have a negative impact as they cover large areas and conducive transport facilities tends to spread urban sprawl over large urban area. To restrict the impact of urban sprawl on the environment compact city concept is one of the most sustainable development approaches which is taken into account. As compared to India, there is a major difference between the city characteristics around the world. This paper reviews the compact city concept and attempt to explore its effects on sustainable development in the Indian condition.

Wu et al. [11 Presented a research outlook achieved from the Highway Safety Enhancement Project (HSEP) that tends to safety performance on two-lane highways in Beijing, China. Potential factors are identified based on proposed evaluation criteria, and primary counter measures are developed against inferior driving conditions such as sharp curves, heavy gradients, continuous downgrades, poor sight distance, and poor clear zones. Six cost-effective engineering solutions were specifically executed to improve two lane highway safety conditions, including (1) traffic sign replacement, (2) repainting pavement markings, (3) roadside barrier installation, (4) intersection channelization, (5) drainage optimization, and (6) sight distance improvement. The effectiveness of these solutions was inspected and evaluated based on Empirical Bayes (EB) models. The results depicts that the proposed engineering solutions effectively improved traffic safety performance by significantly reducing crash occurrence risks and crash severities.

IV. RESEARCH METHODOLOGY

1. The selected Project Study Area Stretch falling in the district of Alapphuza, Kerala and The

1. Project Road is National Highway (NH-66) situated in plain terrain. The total Project Length is 86.34 Km. Start point Ch.374+390 to end point at Ch.460+730.

2. The research stretch for the study is taken from google earth.

3. Chainage wise accident data will be collected from PWD, NHAI or road department along with the Nature of accident, Causes of accident, classification of accidents, Road features, whether condition.

4. Selected Stretch on a Highway or Expressway where accident prone area is to be found.

5. Selected parameters were inspected at every 100m chainage. The stretch is highly prone to accidents. Parameters causing accidents are present at short intervals and therefore to achieve high degree of accuracy, chainage as small as 100m was selected.

6. Comparison of real time data with records available in the police station and NHAI.

7. Separate out the accident data according to maximum accident occurring at particular spot.

8. To identify various traffic and road related factors causing accidents.

9. Separate out Accident data of past 3 years (from 2017 to 2019) bifurcated according to Nature of accident, Causes of accident, Type of Injury (Fatal, Grievous, and Minor), Road Feature, and Road Condition & Weather Condition.

10. The reading taken on (selected site) then analyzed by accident severity index, according to importance of the parameter (ASI)

11. Give top rank and maximum weightage to the location on the basis of number of accidents occurred.

12. Analysis of the top ranked accidental spots.

13. The percentages after giving rank and weightage were calculated and on the basis of Accident

14. Severity Index (ASI) the accidental black spots were identified.

15. To carry out analysis of black spots by using statistical models.

16. Detailed analysis of the identified black spots and study the problems diagnosis at each black spots.

17. Counter measures for accidental spots will also be predicted.

18. Give the Improvement initiatives related to Geometric Design.

19. Comparison Proper measures for Rectification and implementations.

20. Black Spots will be rectified with support of accident data on these locations and will be reduced drastically after Implementation of short-term measures.

V. DATA COLLECTION AND ANALYSIS

To determine the accident-prone area in our selected stretch on a highway the following data should be collected and analyze.

a. Chainage wise accident data will be collected from PWD, NHAI or road department along with the Nature of accident, Causes of accident, classification of accidents, Road features, whether condition.
b. Rough accident-prone locations as suggested by the Police station.

Bifurcation of Accident Data

The accident data are studied of past 3 years (from 2017 to 2019) & current year at their NHAI

office & Police station and bifurcated according to Nature of accident, Causes of accident, Type of Injury (Fatal, Grievous, and Minor), Road Feature, and Road Condition & Weather Condition.

Table 1. Classification of Accident according to their injury type

Year	Injury Type			Total Accident
	Died	Grievous	Minor Injury	
2017	59	235	97	391
2018	56	278	104	438
2019	48	271	141	460
2020	15	140	55	210

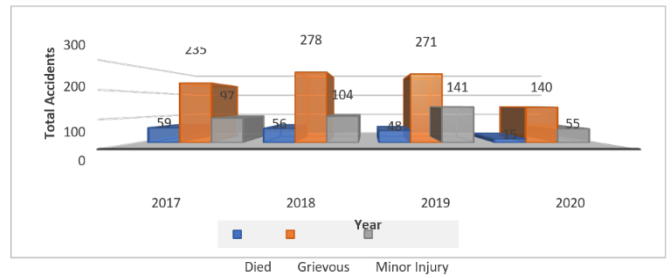Classification of Accident according to their injury type

Figure 1. Classification of Accident according to their injury type

The figure shows that maximum members died in 2017, Grievous accidents are more in 2018, Major injury in 2019. The total accidents are more in 2019.

Table 2. Classification of Accident according to the Road Condition

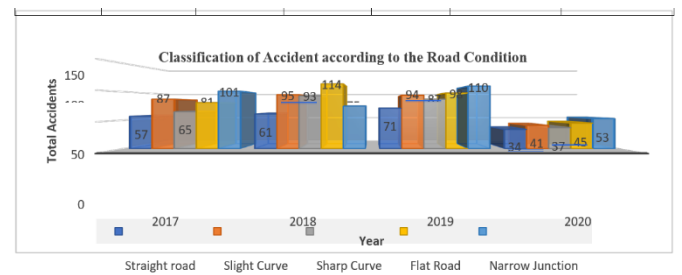| Year	Straight	Slight Curve	Sharp C	Flat Road	Narrow	Total Accid
2017	57	87	65	81	101	391
2018	61	95	93	114	75	438
2019	71	94	87	98	110	460
2020	34	41	37	45	53	210

Figure 2. Classification of Accident according to the Road Condition.

The figure shows that maximum Straight Road accidents took place in 2019, accidents at slight curve is in 2018, at sharp curve is in 93, at flat road is in 2018, at narrow junctions is in 2019. The total maximum accidents took place in 2019.

Table 3. Classification of Accident according to the Nature of Accident

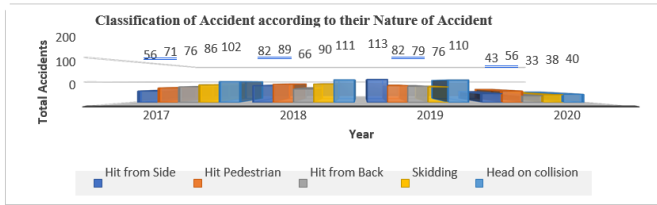| Year	Hi fro m Side	Hit Pedest rian	Hit from Back	Skiddin g	Head on collisi on	Tota l Acci dent
2017	56	71	76	86	102	391
2018	82	89	66	90	111	438
2019	113	82	79	76	110	460
2020	43	56	33	38	40	210

Figure 3. Classification of Accident according to the Nature of Accident.

The Figure shows that hit from side accidents took place more in 2019, Pedestrian hit in 2018, Hit from ack in 2019, Skidding accidents in 2018, Head on collision in 2018. The total accidents took place in 2019.

Analysis of Accident Data by Accident Severity Index Based on the Black Spot accident data collected, Accident Severity Index (ASI) is computed to identify the hazardous locations on the project corridor. In order to find the cruciality of an accident site, a system of assigning scores has been adopted based on the severity of accident. The score called as Accident Severity Index (ASI). Accident Severity Index is a dimensionless value indicating the level of hazard of a spot on the road. T

he following equation has been used:

$$ASI = [Nf \times Wf] + [Ng \times Wg] + [Nm \times Wm] \text{ Whereas,}$$

Nf = No. of fatal accidents at the Patch in the past 3 years

Wf = 6 (Weightage assigned to fatal accident)

Ng = No. of grievous injury accidents at the spot in the past 3 years

Wg = 3 (Weightage assigned to grievous accident)

Nm = No. of minor injury accidents at the Patch in the past 3 years

Wm = 1 (Weightage assigned to minor accidents.

Threshold Value $T = v + [1.5 \times \sqrt{\{(\sum (V-v)2)/(N-1)\}}]$

N = No. of Black Spots

V = ASI = Accident Severity Index

V = Average ASI

Standard Deviation = $\sqrt{\{(\sum (V-v)2)/(N-1)\}}$

VI. RESULTS

Table 4. ASI Values of the locations.

S.NO	Black Spot Location	No. of Fatal Accident 2017 to 2020	Weightage for Fatal accident	No. of Grevious Accident 2017 to 2020	Weightage for Gevious accident	No. of Minor Accident 2017 to 2020	Weightage for Minor accident	ASI Value	Average ASI		
		N_f	W_f	Ng	W_g	Nm	Wm	ASI (V)	v	(V-v)	(V-v)^2
1	KL-176	1	6	4	3	1	1	221	132.4	88.6	7848.9
2	KL-177	1	6	4	3	2	1	226	132.4	93.6	8759.8
3	KL-178	3	6	2	3	7	1	100	132.4	-32.4	1050.2
4	KL-179	2	6	1	3	2	1	56	132.4	-76.4	5837.9

5	KL-180	1	6	5	3	2	1	254	132.4	121.6	14785.0
6	KL-181	1	6	5	3	5	1	26	132.4	-106.4	11322.3
7	KL-182	1	6	5	3	2	1	269	132.4	136.6	18657.9
8	KL-183	2	6	2	3	4	1	91	132.4	-41.4	1714.5
9	KL-184	7	6	5	3	3	1	237	132.4	104.6	10939.9
10	KL-185	3	6	2	3	8	1	98	132.4	-34.4	1183.8
11	KL-186	8	6	3	3	2	1	163	132.4	30.6	936.0
12	KL-187	1	6	4	3	1	1	209	132.4	76.6	5866.6
13	KL-188	2	6	7	3	5	1	38	132.4	-94.4	8912.5
14	KL-189	1	6	1	3	2	1	50	132.4	-82.4	6790.8
15	KL-190	1	6	1	3	9	1	57	132.4	-75.4	5686.1
16	KL-191	4	6	2	3	6	1	90	132.4	-42.4	1798.3
17	KL-192	1	6	4	3	1	1	222	132.4	89.6	8027.0
18	KL-193	3	6	1	3	8	1	71	132.4	-61.4	3770.7
19	KL-194	2	6	1	3	9	1	78	132.4	-54.4	2960.0
20	KL-195	6	6	6	3	2	1	242	132.4	109.6	12010.8
21	KL-196	7	6	3	3	1	1	152	132.4	19.6	383.9
22	KL-197	7	6	4	3	1	1	186	132.4	53.6	2872.3
23	KL-198	3	6	2	3	1	1	116	132.4	-16.4	269.2
24	KL-199	1	6	9	3	2	1	35	132.4	-97.4	9488.0
25	KL-200	7	6	4	3	1	1	186	132.4	53.6	2872.3
26	KL-202	1	6	1	3	1	1	63	132.4	-69.4	4817.2
27	KL-203	6	6	2	3	1	1	118	132.4	-14.4	207.5
28	KL-204	6	6	2	3	1	1	120	132.4	-12.4	153.9
29	KL-205	9	6	2	3	1	1	152	132.4	19.6	383.9
30	KL-206	4	6	1	3	9	1	66	132.4	-66.4	4409.8
31	KL-207	6	6	2	3	1	1	109	132.4	-23.4	547.9
32	KL-208	7	6	2	3	1	1	136	132.4	3.6	12.9

Average	132.41
Standard Deviation	71.87
Threshold Value	240

Figure 4. Accident Severity Index and Threshold Values

VII. MITIGATION OF BLACK SPOTS

Based on site inspection, preliminary survey etc. the type of implementation required may be identified and accordingly the action for taking corrective measures i.e., short term measures and Long-term Measures may be initiated at Authority's Level. As per the requirement of site (Black Spot location) the corrective measures i.e. Short Term Measures only, and in some cases Long Term Measures including Cautionary Measures&/or Short-Term Measures may be taken.
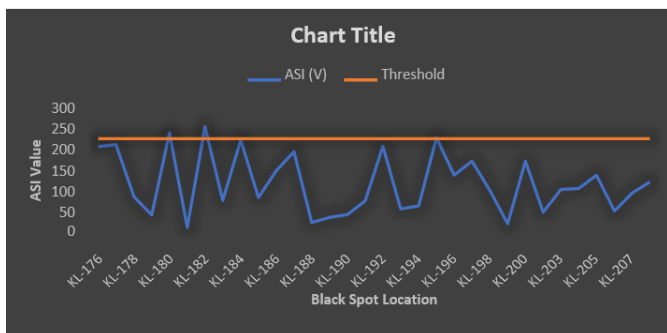
The suggestive measures and recommendation to be followed for rectifications of black spots are as under:

Short term measures: The suggestive items or measures are as under:

i. Pedestrian facilities like Zebra crossings ii. Crash barriers/ railings
iii. Solar light
iv. Junction's improvement
v. Road signs inter-alia speed limits sign, pavement/road markings, delineators, studs/ cats' eye.
vi. Providing rumble strip for traffic calming.
vii. Repairing or maintenance of unsafe road including filling of shoulder on National Highways
viii. Restriction of certain types of vehicles, one-way streets, reversible lanes, bus lanes, restriction on movement of different types of vehicles at a time etc. specially in urban areas.

VIII.   CONCLUSION

This study is an attempt to find out the blackspots in Kerala. The Accident Severity Index (ASI) method was used to rank the accident locations. This method was found to be effective in identifying the blackspots. Based on the analysis, and the results, ASI is 132.41, Standard Deviation is 71.87, Threshold Value is 240. we proposed the short-term measures for the blackspots until the long-term measures come into exitance.

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