Black Spot Analysis: A Case Study of Pune City

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Abstract- *The distinguishing proof of street segments portrayed by high hazard mishaps is the initial step for any fruitful street wellbeing the executives procedure, thinking about the restricted accessible assets. Although researchers started to study black spot decades ago, there are many un-clarified questions in this fieldIn the recognizable proof procedure of dark spots three fundamental techniques can be utilized: screening strategies, bunching strategies and crash expectation strategies. Numerous literary works and contextual investigations were composed depicting every technique professionals or cons. These writings focus for the most part on one sort of street each time, in spite of the fact that street attributes (for example speed, ADT) can exceptionally influence the achievement and accuracy of the connected strategy.. Therefore, the most important question to be answered is which method for which road?. This question can be answered by comparing different applied methods for different road types. However the comparison of different methods is still not adequately explored areas. This article plans to analyze distinctive techniques utilized in distinguishing dark recognize; the sliding window and the spatial autocorrelation for two sorts of streets contrast in their normal speed, where speed is one of the significant street qualities which is as yet not sufficiently investigated. The result shows a preference to use the sliding window for identifying black spot in high speed roads and the lack of preference to use it in low speed streets, and the other way around for spatial autocorrelation technique, following mishaps dissemination design. Furthermore, an aftereffect of a shortcoming in applying Empirical Bayesian in Fast Street is additionally included.*

Keywords- black spot analysis of the Road

I. INTRODUCTION

Road network of a country is one of the most important factors responsible for the economic and social development of that country. India has a high population and requires a large amount of transportation services like air, land and water transportation. Road network is the only means of transportation which has deep penetration in all areas and responsible for door to door service. Hence it is very important to increase and maintain the road network of our country. Maharashtra is one of the fastest growing states in India. The main reason for its development is its wide road network which facilitates a better and faster transportation which helps in its overall development. With increase in population the number of vehicles is also increasing which are responsible for occurrence of more number of accidents. This causes an obstruction is the economic and social development. To avoid this accident prone zones on the highways must be studied, identified and rectified to reduce the accidents. A unintentional dark spot is a term utilized in street wellbeing the board to mean a spot where street auto collisions have generally been concentrated. It has been observed that almost 13 people die in road accidents all around the world every hour. According to World Health Organization (WHO) road accidents are the leading cause of death amongst people aged between 15-29.

At the time of designing of national highway, vision is to construct accident free highway for that purpose normal causes of accidents are taken into consideration. For present study accidental data collected from National Highway Authority of India NHAI is analyzed by Ranking Method and black spot on national highway was found out

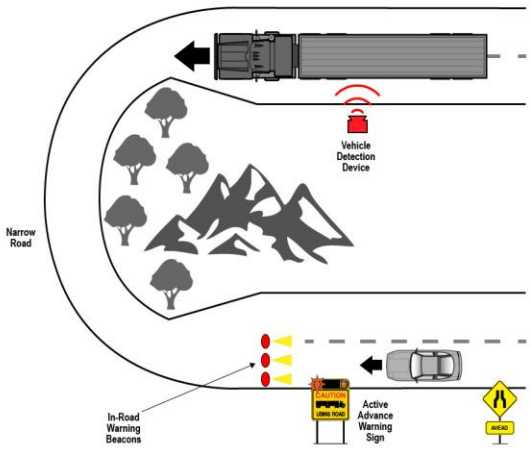


Fig 1 Black Spot of the Road **(https://www.ijert.org/)**

WHAT IS BLACK SPOT

A mishap dark spot is a term utilized in street security the board to signify a spot where street auto collisions have verifiably been concentrated. Black spot methods are

designed to identify the prone spots in particular stretch and reduce the crash risk in that area by providing remedial measures. Identification of locations for safety improvement is the starting point of all the processes. The process is sometimes known as black spot identification or hazardous identification location. Generally black spot are termed to define the location where many accidents have occurred and risk (severe, major, and minor) is involved in that accident

II. OBJECTIVE

The objectives of this study are specifically given as following.

- To develop a methodology to identify and prioritize hazardous locations and to find out the most vulnerable accident stretch.
- To find out most vulnerable accident stretches in Pune Solapur Highway by applying the methodology developed.
- To identify various traffic and road related factors causing accidents and suggestion of possible improvements.

Causes of black spots and their remedial measures

Insufficient law enforcing agencies, improper road infrastructure, lack of proper warning signs, inadequate illumination on footpaths and cycle tracks, poor emergency response capability and injustice in the implementation of traffic laws are the main causes of road accidents. Transporters do not care for the fitness of their vehicles and keep on modifying the chassis/ frame of their vehicles without engineering specifications. They equip their vehicles with illegal and inappropriate manner and engage such drivers who are alcoholics and drug users on low wages. Lack of proper driving school also leads to accidents

While conducting black spot study in an urban area, after collecting the accident's information from respective agencies, police stations, analysis of the location should be made using spot speed studies, vehicles classification and driver studies, cost benefits and other relevant set of studies. Further steps adopted for analysis of black spots are: recording the accidents and data entering onto computer; finding sites with high number of accidents and commonly known as black spots; weight sites for severity and exposure. Initial accident investigation and site visits; rank sites for in depth investigation; collection of further data from accident forms/site studies; analysis of data; more detective work; human factors; select and check packages of counter measures; rank sites for treatment, implementation and construction; monitor behavior during first days and months; evaluate the effects on accidents and cost-benefit analysis.

Visibility Effects

Poor visibilities, inadequate sight distance, braking distances especially on curves are the major factors in the creation of black spots. At grade intersection if links are not properly designed they may create visibility problem in the driver's vision. Adequate sight distance as provided by AASHTO, Green book helps drivers to safely negotiate the hazards while travelling at design speed.

Geometric Effects

Wrong and incompatible geometric designs may leads to sever accidents. Number of black spot in the road length depends on many factors. In plan areas and straight alignment of the road, design speed, visibility, width and number of lanes, shoulders width and conditions and median types have great effects towards the safe movement of vehicles and its service capacity. It further depends upon the type of roads on its functional classification. In rolling and mountainous terrains, maximum and minimum grade, critical length of upgrade, provision of climbing lanes, presence of hidden dips, roller coasters, sky line horizons, selection of curve type, width and number of lanes are the major geometric parameters that has mainly be concerned with the black spot identifications.

Table 1 Maximum grades for urban Arterials
(https://www.ijert.org/)

Type of Terrain	Design speed (mph)								
	40	45	50	55	60	65	70	75	80
Level	5	5	4	4	3	3	3	3	3
Rolling	6	6	5	5	4	4	4	4	4
Mountain	8	7	7	6	6	5	5	5	5

Over Speeding And Reckless Driving

Speed is a significant transportation thought since it identifies with security, time, solace, comfort, and financial aspects.. On account of the measures, which have been taken, the citizen has readily accepted the system of policing introduced on the motorway. In a little over three years the Motorway Police has penalized 146,752 offenders mainly due to over speeding. Only 470 contested police action and there have been no complaints with regards to their conduct . The

solution to over speeding and aggressive driving is to check the vehicle's spot speed on the roadway

Human Errors

The key factor behind the human behavior towards road accidents is the age, profession, education and standard of living or the financial status. It has been observed that youngsters tend to be fast drivers than aged persons. Although this trend exists for both men and women, but women do not drive as fast as their male contemporaries and this habit pertains to an age of about 40 years . According to National Research Centre Data Bank, human error was the sole cause in 57% of all accidents and was a contributing factor in over 90%. In contrast, only 2.4% were due to mechanical fault and 4.7% by environmental factors. The reasons why humans make so many driving mistakes are to be looked into the inherent limitations of human information processing. People must depend on three questionable mental capacities: discernment, consideration and memory... The identification of the problems based on the above stated facts which are related to drivers and vehicles can provide guidelines for future efforts in the direction of crash and black spots avoidance

Vehicular Conditions

Contribution of static and dynamic characteristics of vehicles cannot be denied in the analysis of black spots. Static characteristics of vehicle affecting road design are the dimensions, weight and height of driver's seat, clearance and maximum turning angle of vehicle. Whereas dynamic characteristics of vehicles affecting road design are speed, acceleration, vehicle stability, braking characteristics and some aspects of vehicle body design.

Time of Day

Early hours of the morning and the middle of the afternoon are the peak times for fatigue accidents and long journeys on monotonous roads, particularly on motorways, and mostly drivers fall in sleeps during that period of the day. There are difficulties in determining the level of sleep related accidents because there is no simple and reliable way for an investigating police officer to determine whether fatigue was a factor in an accident. This result in varying estimates of the level of sleep related accidents. A study of road accidents between 1987 and1992 found that sleep related accidents comprised 16% of all road accidents and 23% of accidents on motorways

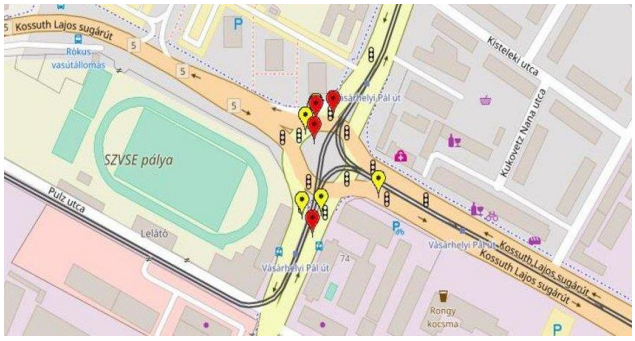


Fig 2 Black Spot of the Road (https://www.ijert.org/)

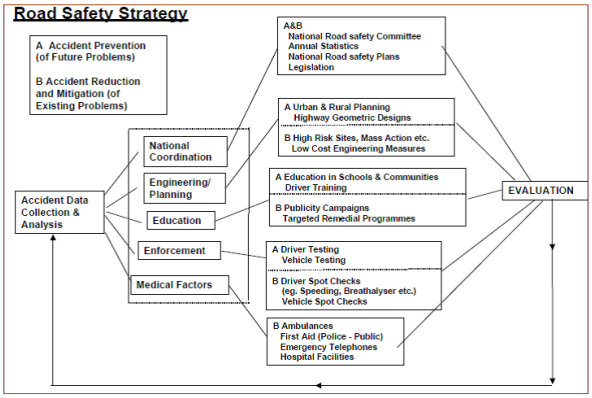


Fig 3 Road Safety Strategy (https://www.ijert.org/)

III. LITERATURE REVIEW

As described by Virtisen (2002), locations were ranked at first according to their reported number of accidents. Locations with a number exceeding a chosen threshold value were targeted as hot spots (see e.g. Jorgensen (1966)). This strategy is delicate to irregular variety in mishap checks and to the relapse to the mean issue (see for examplesee e.g. Hauer (1986), Elvik (1997)). Along these lines, the normal number of mishaps, assessed from a model was utilized.. However it is well established that, in general, there are considerable differences between the expected number of accidents at different types of intersections and road sections. This might be inexpedient, as the best arrangement will finish up adjusting the area into an alternate street type.. Such alterations are often too expensive and/or impossible.

McGuigan (1981) recommended positioning locales as per their potential for mishap decrease (PAR), which is the distinction between the detailed number of mishaps at an area and the normal number. of accidents at a location and the expected number at locations with similar characteristics. Persaud et al. 1999) proposed utilizing an exact Bayes gauge rather than the mishap include in PAR . Persaud et al. utilized a Poisson-gamma summed up straight model with qualities, for example, traffic stream and different geometric factors.. In Saccomanno et al (2001) the aftereffects of a multivariate

Poisson relapse models and Empirical Bayesian strategies are thought about for building up the potential for mishaps and Steunpunt Verkeersveiligheid 11 RA-2003-07 designating safety black spots along a highway. The Empirical Bayes model was found to yield fewer black spot locations than the Poisson regression model.

The errand of focusing on dark spots might be seen as a positioning and determination issue (see e.g (see e.g. Dudewicz and Koo (1987)) and parallel with the PAR-method, Gupta and Hsu (1980) introduced the so-called probability of correct selection (PCS). In a group of locations a subset is targeted as hot spots, if the probability of hereby selecting the site with the largest expected number of accidents (the 'worst' location) is above a chosen threshold value. Later Hauer and Persaud (1984) determined the likelihood of right choice for a Poisson-gamma model. was used as a measure of the overall efficiency of the targeting method and not directly used for targeting hot spots. Schlütler et al (1997) determined the PCS for an individual site as the back likelihood of being 'most noticeably awful' in a Poisson-gamma model with no area attributes. Heydecker and Wu (2001) later extended the PCS measure in Schlütler et al to include location characteristics and defined PCS as the probability of the Poisson rate exceeding a chosen threshold.

In Van den Bossche et al (2002) investigation is done on the question whether a ranking alone can give enough evidence for the selection of dangerous sites. More specifically, Bayesian hierarchical modelling techniques are used to identify and rank hazardous intersections for bicycles in Leuven, a small university town in Belgium. The authors conclude that ranking hazardous sites is an interesting means to get insight in dangerous locations, but there is no such thing as "the" correct ranking.

Virtisen (2002) portrays that high-chance destinations are focused with the point of improving wellbeing out and about system through healing treatment of the locales.. Any achieved positive effects of safety measures at accident hot spots are denoted the benefits of the implemented measures. Actualizing wellbeing measures is expensive, however in principle, all estimates creating a positive net-advantage ought to be executed. However, the restricted funding for hot spot safety work does put a limit to the number of sites that may be treated. Therefore, it is necessary to prioritise between sites and safety measures in order to utilize the limited funds as effectively as possible.

In Nassar (1996) an integrated Accident Risk Model (ARM) for policy decisions is developed using risk factors affecting both accident involvements on road sections and injury severity of occupants involved in the accidents. Again, the accident involvement model is based on a negative binomial regression. This model can give assessments of the quantity of vehicle associations on street segments by locale, street type, vehicle type and mishap area.. The accident severity model is developed and evaluated using a sequential binary logit formulation. The model is able to provide occupant specific injury profiled by region, road type, accident type and vehicle type. The integrated structure of ARM permits an estimate of road accident risk in terms of the number of vehicles involved, and fatalities and major injuries to occupants. It additionally allows the recognizable proof of hazard factors clarifying both mishap association and seriousness. However, the model application for policy is limited.

The most appropriate level of spatial aggregation for road accidents is the road section, but in most studies its length is not justified and not controlled (see Thomas, 1996 for a review). No unmistakable sign exists of what the best length of an unsafe street portion ought to be, nor or whether an ideal length can be characterized Minister et al (1975) make a qualification among 'short' and 'expansive' interstate fragments, individually called spots and areas.. The lengths are chosen in order to limit the heterogeneity within each road segment, but the authors recommend the use of a constant length because the interpretation of accident data would be more complicated for sections of variable length. Okamoto and Koshi (1989) propose seven different ways of characterizing street fragments: some depend on fixed lengths and other on factor length..

Stern and Zehavi (1990) isolate the street examined into 1-km-long areas, with no specific defense for this length.. Elvik (1988) Elvik (1988) proposes characterizing perilous street segments of a fixed length, by moving a 'lightweight flyer' of a particular length along the street. However results are not found to be satisfactory with this method.

In Flahaut et al (2002) the idea of dark zone is utilized to handle the issue of the length just as the area of street areas, considering the contiguity structure of the fundamental individual spatial units A dark zone is here characterized as a lot of adjoining spatial units taken together and portrayed by a high number of mishaps... No attempt is made to find out which factors explain the occurrence of accidents, or which countermeasures should be taken to reduce their number The examination centers around an exploratory spatial information investigation issue: characterizing the area and the length of dark zones. Two techniques are looked at: the utilization of nearby spatial autocorrelation lists (a decay of the worldwide Moran record) and bit estimation.. Both

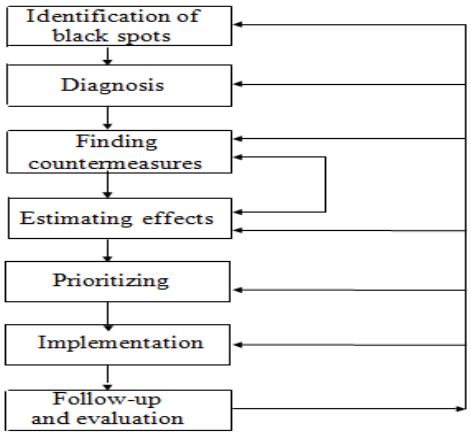
methods differentiate local dangerousness and generate a smoothing of the empirical process. Although each method starts from different conceptual approaches both may give very comparative outcomes under a particular selection of parameters and lead to a meaning of non-bordering dark zones. Steenberghen et al (2002) show the usefulness of GIS and point pattern techniques for defining road accident black zones within urban agglomerations The area of street mishaps depends on powerful division, address geocoding and convergence recognizable proof..

One-dimensional (line) and two-dimensional (region) bunching procedures for street mishaps are looked at.. Favorable circumstances and disadvantages are talked about in connection to network and traffic qualities. Direct spatial grouping methods seem, by all accounts, to be more qualified when traffic streams can be unmistakably distinguished along specific courses. The imbalance results in statistically significant differences in concentrations of accidents. The importance of the environmental factors in relation to the traffic characteristics needs to be further researched to better identify which combinations generate higher concentrations.
In Vistisen (2002) also a new method for estimating the effect of hot spot treatment work is proposed. The model is based on the site safety estimates provided by the accident models, and takes into account the regression to the mean effect as well as changes in traffic flow and other traits. The proposed method is found to give better estimates of the effect of treatment than the method currently used in Denmark. In addition, the researchers claim that it outperforms the methods as yet suggested in the international literature. The improved estimates of treatment effect will improve the foundation for prioritizing of black spots and safety measures.

IV. METHODOLOGY

The process of eliminating or improving accident black spots in a road network is composed of several activities, as illustrated in the following figure.

- **Identification of black spots** is the procedure to locate those spots in the road network that is particularly dangerous, that is, the black spots.
- **Diagnosis** is the process to study what are the problems, the accident contributing factors and the deficiencies for each of the identified black spots.
- **Finding countermeasures** implies a methodical analysis to design suitable countermeasures for each black spot, based on actual problems and deficiencies.
- **Estimating effects** is the process to estimate the safety effects (and if necessary also other effects) and costs of suitable countermeasures.
- **Prioritizing** implies finding the best action plan (or investment program), according to some defined criteria, and based on estimated effects and costs as well as budget restrictions.



- **Implementation** is the actual realization of the prioritized measures included in the action plan (or investment program).
- **Follow-up and evaluation** is the last and very important step, which aim is to assess the actual results (effects and costs).

The methodology suggested for study includes

- To collect accident data on Pune Solapur National Highway from National Highway Authority of India.
- Detailed analysis of the identified black spots.
- To find out different methods to prioritize hazardous locations.
- To identify various traffic and road related factors causing accidents.
- The reading taken on Pune-Solapur National Highway then analyzed by method of ranking. According to importance of the parameter.
- The most important parameter because of which more number of accidents is occurred had given top rank and maximum weight age.
- Analysis of the top ranked accidental spots.

The percentages after giving rank and weight age were calculated and on the bas

V. CONCLUSION

Major causes behind the high accident rate in Pakistan are the lack of proper system to record and control accident black spots. In each accident, rate of death is 30%. Accidents never happened due to single cause, but it involves many factors that have to investigate thoroughly before concluding the results.

Systematic accident reporting and recording centers must be established with the help of different highways agencies, so that regular monitoring and identification of black spot can be possible. Deficiency in Geometric design play a significant rule towards accident, which should be checked and counter measured with engineering concepts.

Most of the accidents are not merely due to some serious causes, but ignorance of some minor causes may results major accidents. It also emphasizes the need to understand the importance of minor weakness and flaws in the road traffic system and their low cost remedial measures. Lack of proper warning signs, road markings, signals, inadequate illumination on footpaths and cycle tracks, poor emergency response capability and injustice in the implementation of traffic laws are the main causes of road accidents. Traffic accidents are rich with spatial information. But in general, the location of traffic accidents is described as an address as text, so the spatiality is difficult to present. Aided by geocoding technology, spatial coordinates of traffic accidents are generated. They are consistent with the coordinate system of the road network and can dis-play on the urban road network visually.

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