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Road Ways Hot Spot Design Optimization with Calibration of Geographical Side

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Abstract-In this a literature review is given of the methods and techniques that are used to analyse black spots and black zones. Although, no universally accepted definition of a black spot or black zone is given, these locations will in general be described as high risk accident locations. In this context, several statistical models are described in literature to model the accident frequency and accident severity.

Keywords:- Road traffic accidents; black spots; visual analytics

I. INTRODUCTION

Today the most negative effects of building and developing transportation systems are related to road accidents with live losses. The social and economic losses are another costs added to road accidents. Implementation of safety measures are costly, although all of it has a positive net benefit, but restricted funds put limitations on the number of sites that may be treated. Therefore, it is necessary to define the priority of the high risk sites and their related safety measures in order to utilize the limited fund as effectively as possible.

This article aims to compare two different accidents' black spot (BS) identification techniques; the sliding window (SLW) screening method and the spatial auto-correlation (SPA) method, considering crash data on two types of roads that have almost similar characteristics but differ significantly in their average speed, and applying the empirical Bayesian (EB) as an evaluating third method.

In previous literatures, it was claimed that the length of road segments used for identifying BS as in SLW method have a substantial influence in determining the real dangerous accident locations and consequently could result in many false positive (i.e. a site involving in safety investigation while it isn't needed) or false negative (i.e. not involving a site in safety investigation while it is needed). Therefore, different clustering techniques have been developed in order to tackle the problem by identifying the minimum real length of BS locations. However, if we consider the basic objective in identifying the road accidents BS, it is to find a point, an object or a small section in a road that cause all of these dangerous accidents. Therefore, using clustering techniques can be more useful in reducing the length of the study BS area by detecting the exact location of accidents' spatial aggregation.

II. ROAD SAFETY AUDIT MITIGATION OF BLACKSPOT ON THE HIGHWAYS

What is a black spot? In general, identification of the site with potential safety problem is the first and important step in the accident mitigation process.

The technique to determine whether a site has a safety problem varies from place to place and is referred to by different names. Methodologies vary from the simple flag sites that have high-accident records to the more complicated ones of which the expected number of accidents is estimated and potential for safety improvements is determined.

However, the most widely used technique to determine whether a site has a safety problem, is based on the road accident history and this is known as determination of 'Black Spot Locations'. Also, the whole accident mitigation process is often referred to as Black Spots Improvement. Identification of black spots is a procedure to locate such spots within the road network. In reviewing the literatures, several methods are found for black spot determination that

have been researched and proposed over past decades. Nevertheless, for practical ability, in many countries, the black spot definition is stated very simply.

For an example, in Australia, the definition4 of the black spot is given as: 'for individual sites such as intersection, mid-block or short road section, there has to be a history of at least 3 casualty crashes in any one year, or 3 casualty crashes over a three year period; 4 over a four year period; 5 over a five year period, etc. For lengths of road, there must be an average of 0.2 casualty crashes per kilometer of the length in question over 5 years; or the road length to be treated must be amongst the top 10% of sites with a demonstrated higher crash rate than other roads in a region 4.' Thailand has yet to adopt officially a method to identify black spot locations or even an official definition of black spots.

However, in 1999 the Ministry of Transport and Communications commissioned the SweRoad of Sweden together with local consultants to carry out a comprehensive road safety project in Thailand5. Among various proposed strategies, black spot improvement program is also presented.

Road safety audits are appropriate for all kinds of road construction, including rehabilitation and upgrading, as well as new-build. They can also help in assessing the safety of:

- Arrangements for traffic control and signing at roadworks
- Traffic management schemes
- Major roadside building development (e.g., shopping malls, car parks, leisure centres, etc)
- Existing roads

The earlier a road scheme is audited within the design and development process the better. For road construction projects there are five main audit stages:

- Feasibility Study Audit
- Preliminary Design Audit
- Detailed Design Audit
- Pre-opening Audit

Safety audits involve three parties with defined roles – the Auditor, the Designer, and the Client:

- The Auditor (audit team) is commissioned by the Client to perform the audit and produce an audit report which identifies the safety problems and suggests what should be done about them;
- The Designer is the party responsible for the design (often a consultant); they will be invited to comment on the audit report and, if necessary, will be instructed by the Client to alter the design;
- The Client is the road authority who commissions the audit and decides whether the audit recommendations should be accepted or rejected.

III. THE IMPORTANCE OF ROAD SAFETY AUDIT

Road Safety Auditing is a specialist process that must be carried out independently of design and construction work. Road Safety Audits are intended to ensure that operational road safety experience is applied during the design and construction process in order that the number and severity of collisions are kept to a minimum.

Road Safety Audits fulfil a vital role in checking that roads have been designed and built to the highest safety standards. A well carried out Road Safety Audit adds value to a highway scheme at every level.

IV. OBJECTIVES OF THE PRESENT RESEARCH WORK

The objectives of the present research can be divided into four parts namely

- Identification of black spots and to suggest their remedies.
- Developing suitable statistical model for the analysis.
- Identifying the causes of accidents through survey based on questionnaire.

V. PREVIOUS METHODOLOGY

The model described in this paper requires a map of the desired road network digitized in a suitable form and certain specified road attributes to carry out prioritization The analysis then identifies accident black spots on the given road network. While carrying out the analysis the model only incorporates the road related factors such as road geometries, which lead to accidents. The factors considered for evaluating accident prone locations on road are as follows:

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- Road width.
- Number of lanes.
- Approximate number of vehicles per day.
- Type of road.
- Drainage facilities.
- Surface condition of the pavement.
- Frequent vehicle type.
- Presence of shoulders, edge obstructions, median barriers and ribbon development.
- Radius of horizontal curve. In order to model the mentioned factors and achieve the desired result, a step-by-step procedure as given below is adopted.

1. Need for the Present Research Work:

Since independence, India has witnessed tremendous economic growth which has resulted in the expansion of road network and subsequent increase in vehicular population. This had a considerable impact on operation and safety of traffic. With more than one death and four injuries every minute, India has the dubious distinction of reporting large number of road fatalities in the world (Siva Kumar et al 2012).

Moreover, there have been strong indications over the past decades which placed „road traffic injury" on 9th position among the 10 leading causes of deaths (Global status report on road safety 2011).

The World Health Organization (WHO) has revealed in the global status report on "road safety" that fatal accidents are more on Indian roads than anywhere else in the world. This emphasizes for a comprehensive analysis of highway crashes at the stage of planning and designing.

2. Road Safety Audits:

- Guidelines on carrying out road safety audits are notified.
- As no mapped data on most of the existing road net work and its road side environment is available, mapping these details is made part of the audit to make the audit objective and result oriented.
- Surveying & mapping the road stretch besides making the audit objective, becomes handy in framing solutions and saves time in that activity as the recommendations would be acted up on immediately.
- Responsible and accountable two way interaction between the audit team and the Highway authorities is incorporated in the guidelines.

VI. MATERIALS AND METHODS

Definition of Black Spot Though no universally accepted definition of a black spot or black zone has been given, these locations are generally described as high-risk accident locations. Determining whether a place is a black spot depends on different definitions.

In Australia, the definition of a black spot is given as: for individual sites such as an intersection, a mid-block, or a short road section, there has to be a history of at least three casualty crashes in any one year, three casualty crashes over a three-year period, four casualty crashes over a four-year period, five casualty crashes over a five-year period, etc.

For lengths of road, there must be an average of 0.2 casualty crashes per kilometer of the length in question over five years, or the road length to be treated must be amongst the top 10% of sites with a demonstrated higher crash rate than that of other roads in a region [16].

Identifying a black spot mainly depends on the definitions used. In circumstances of the urban road, a black spot may be an intersection, a section of road, or any other location that meets the definition. Therefore, this research mainly focuses on urban road black spot identification. The accident time, number, and location are essential because they provide an advantage in practice. Combined with previous definition research, this research mainly refers to the rules of black spot identification that were promulgated by China in 2001.

Ultimately, the urban road black spot is regarded as being the following: For a road section within 500 meters or an intersection within 150 meters, there has to be a history of at least three casualty crashes in any one year, which means that a normal number of accidents is three in 500-meter road section or 150 meters of an intersection a year.

1. Firefly Clustering Algorithm to Identify:

The Black Spot According to the distribution characteristics of a traffic accident point, it happens randomly for a single traffic accident. However, when several accidents occur continuously in one place of an urban road within a certain period, they must be impacted or affected by some external factors. This phenomenon of aggregation is very similar to the

firefly clustering phenomenon, so this research intends to introduce the Firefly Clustering Algorithm to identify black spots, because it is an efficient, stable, and widely applicable method that is suitable for different types of accident data. In addition, the Firefly Clustering Algorithm can also mine the similarity of accidents. The Firefly algorithm was developed by Xin-She Yang [17,18] and is based on the idealized behavior of the flashing characteristics of fireflies.

To concisely describe our firefly algorithm, this research uses the following three idealized rules:

- All fireflies are unisex, so one firefly will be attracted to other fireflies regardless of their sex.
- An important and interesting behavior of fireflies is to glow brighter, mainly to attract prey and to share food with others.

2. Previous Method of Black Hot Spot Detection

2.1 Information Management: The valuable public inputs from the earlier stage should be organized and processed in an established manner so that it is effective. A database management system can play a major role in gleaning information from the gathered data. The Geographic Information System (GIS) and database software should be used to execute the database. This will provide the capability to store data, update data, retrieve data, compare data and spatially display the data through GIS.

2.2 Identification Method: In order to avoid biased results, as the obtained information are gathered in the subjective manner, it is important to construct a process to transform this subjective road safety information into a quantifiable data through a representative value. To achieve this, a safety index is required. One such available technique is the statistical quality control method. This method can be applied to formulate a critical value. Locations are identified as black spots if their safety index is greater than the formulated critical value.

2.3 Program Validation: Questions concerning the reliability and the accuracy of the findings arise whenever one considers public inputs, which consists of perception data gathered in a subjective manner. Since the black spot locations identified via APPP are based on a subjective approach, the effectiveness of the program requires validation. The actual accident data or objective data available is employed for verification. The black spot locations identified via APPP is validated against those identified via a conventional method based on objective accident data.

Road safety is one of the most important problems in our society. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents. If current trends continue road traffic accidents are predicted to be third leading contributor to the global burden of Disease and injury by 2020 (Torregrosa et al.,2012)India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India. India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India (Shiv kumar and Krishnaraj,2012).

The various causes of accidents may be due to three factors shown in fig 1.

- Driver
- Vehicle
- Road Environment

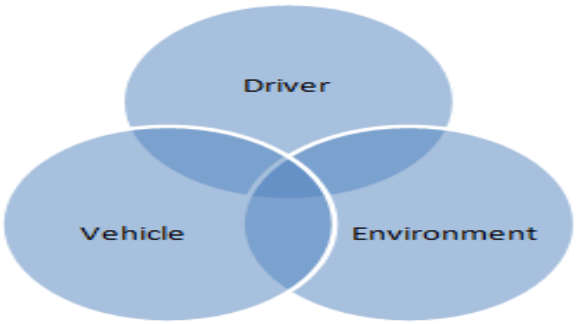

Fig 1.various causes of accidents**.**

3. Objective of the Study

The primary objectives of the study are:

- To identify the engineering factors that may contribute to the cause of accident,
- To identify the black spot and give preventions
- To propose improvements at the location.

4. Parameters Of Genetic Algorithms:

A number of parameters control the precise operation of the genetic algorithm. They are:

4.1 Crossover Probability: It is the measure of how often crossover will be performed. If there is no

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crossover, offspring are exact copies of parents. If there is crossover, offspring are made from parts of both parent's chromosome. If crossover probability is 100%, then all offspring are made by crossover. If it is 0%, whole new generation is made from exact copies of chromosomes from old population. Crossover is made in hope that new chromosomes will contain good parts of old chromosomes and therefore the new chromosomes will be better.

4.2 Mutation Probability: It is the measure of how often parts of chromosome will be mutated. If there is no mutation, offspring are generated immediately after crossover without any change. If mutation is performed, one or more parts of a chromosome are changed. If mutation probability is 100%, whole chromosome is changed, if it is 0%, nothing is changed. Mutation generally prevents the genetic algorithm from falling into local extremes and helps in recovering the lost genetic material. Mutation should not occur very often, because then genetic algorithms would act as to random search.

4.3 Population Size: It is the number of how many chromosomes are present in the population (representing one generation). If there are too few chromosomes, genetic algorithm has few options available for crossover and only a small part of search space is explored. On the counterpart, if there are too many chromosomes in one population then the speed of genetic algorithm slows down.

4.4 Selection Pressure: Each of the genetic operations - crossover, mutation or replacement involves both parent and child chromosomes. The selection of parent chromosomes is biased towards highly fit chromosomes. More fit chromosome is more likely to be a parent than an unfit one in genetic operations. The selection pressure is defined as the ratio between the probabilities that the fit member of the population is selected as a parent to the probability that an average member is selected as a parent. Too high selection pressure would result in the population converging too early, sometimes leading to premature convergence.

4.5 Number of Operations: The genetic algorithm starts off with a random population of chromosomes. Genetic operations (crossover, mutation, replacement) are then applied iteratively to the population. The parameter-number of operations is the number of operators that are applied over the course of a genetic algorithm run.

VII. RESULT AND ANALYSIS

1. Study Stretch and Data Collection:

The study stretch was selected from Chainage Km 335.170 to Km 380.00 on SH-5 which connects Halol to Shamlaji in Gujarat state. The accidents data were collected from L&T, IDPL Toll Plaza with prior permission. The Study Stretch is shown in Fig.

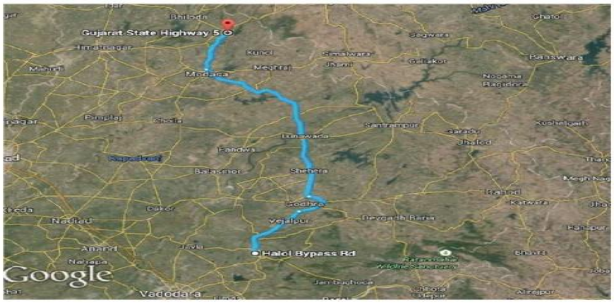

Fig 2. Study Stretch (Source: Google Map).

2. Accident Data:

The accident data collected during last 2 years were plotted with MS excel.Total no of accidents, fatalities; injuries are shown in Table 7.1.

Table 1. Accident data collected.

Year	2013	2014
Total no. Of accidents	443	471
Person killed	51	30
Person injured	274	392
Non-Injury	118	49

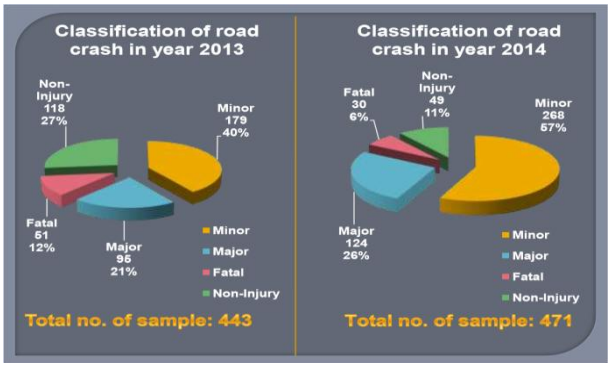

Fig 3. The accident data.

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3. Data Analysis:

The classification of road crash as described earlier has been coded in four different categories as per NHAI coding. The amount of fatal road crashes is 8.39 per cent of the total road crashes. Classification of road crash show in figure.

3.1 Classification of road crash Section 1 (Chainage:335.17 to 369.21 + Godhra Bypass 10.22) Km:

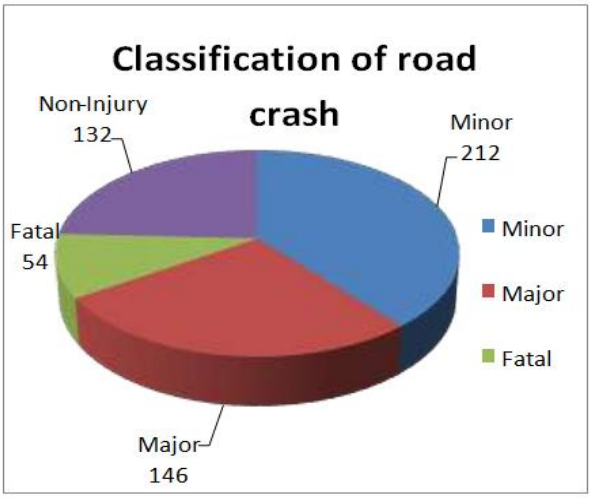

Fig 4. Classification of road crash.

3.2 Nature of Road crash:

The nature of road crash as described earlier has been coded in seven different categories.While analyzing the nature of road crash it has been found that 223 (41 per cent) of road crash contributed to single vehicle show in Figure.

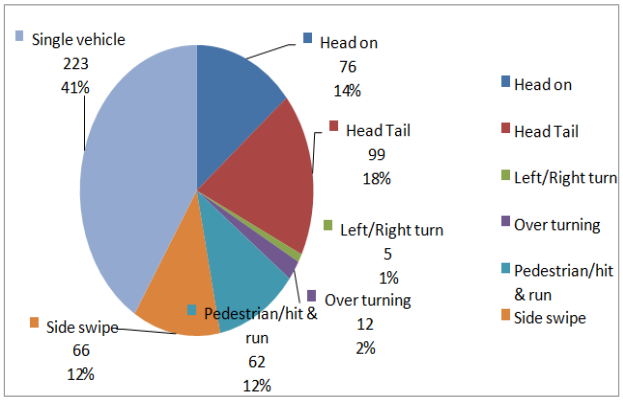

Fig 5. Nature of Road crash.

3.3 Causes of Road crash:

The causes of road crash as described earlier have been coded in four different categories.

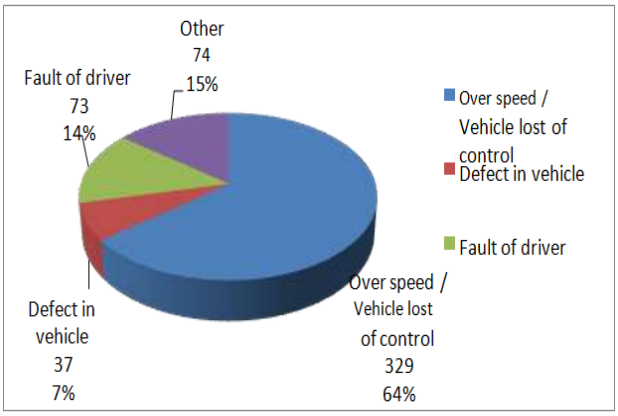

Fig 6. Causes of Road crash.

"SPEED THRILLS BUT KILLS" the catchline is perfectly matched as more than 3/4th of the road crash has occured due to over speeding.

3.4 Time of Road Crash:

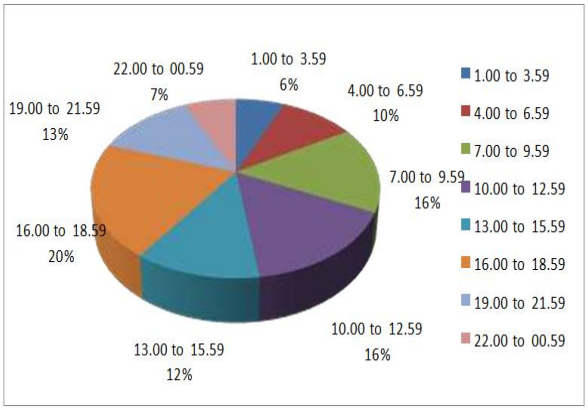

Fig 7. Time of Road Crash.

Time has been divided into eight parts of 3 Hours interval each. It has been observed that around 20 per cent of the road crash has occurred during early afternoon hours i.e. between 16:00 p.M. and 18:59 p.M.(fig 4. 2) this may be attributed to the fatigue and drowsiness experienced by the drivers due to overnight driving.

4. Black Spot Identification:

A "black spot" is defined as any location that exhibits a collision potential that is significantly high when compared with some normal collision potential derived from a group of similar location. Normally the number of road crashes at a particular site will vary widely from year to year, even if there are no changes in traffic or in the road layout. In statistical terms, road crashes at individual sites are rare, random, multifactor events.

This means that comparison between the numbers of road crash at particular site must be made with respect to a fixed time period, typically one year. Furthermore, a single year data will be subjected to considerable statistical variation.

Ideally, several years data are required, from which a mean, annual road crash rate can be calculated. Three years is generally regarded as a practical minimum period for which a reasonably reliable annual average rate can be calculated. Due to non availability of the data for three years, in this analysis one year data has been considered to discover the road crash prone locations.

VIII. CONCLUSION

This study gives an overview of these models. Additionally, several alternative methods that are used to identify and rank black spots are described.

Furthermore, some techniques that are used to profile these accident locations and the use of before- and after studies to estimate the effect of treatment on these sites are discussed in this Review article. The preventive measures brought through this study further control us to control or cut down these rates by utilizing diverse new safety measures, infrastructural configuration fatalities and most recent vehicle engineering.

The central purpose of mishap aversion and control methodology is depending on 4 E's, vis.

- Education,
- Enforcement,
- Engineering and
- Environment and Emergency consideration of road accident exploited people.

IX. FUTURE SCOPE

As presented in the previous sub-sections, it can be concluded that public can identify the black spot locations that are spatially matched with those locations identified through the historical accident data recorded in the KKH's Trauma Registry Database.

Furthermore, mismatched locations have implications for crash prevention as it may provide proactive data to identify locations for further safety investigation. Mismatched location should be studied further to identify other dangerous components such as roadway conditions, physical characteristics, injuries pattern and motorist's behavior. If these analyses reveal that the mismatched location is abnormally dangerous, this will confirm the success of the proposed APPP concept.

Besides, the questionnaire result reveals that most of the respondents agreed with the APPP concept. It reveals their strong attitude in supporting this program. Respondents found the program useful and worth being implemented in their community.
Thus, it can be said that there is a strong potential for successful implementation of the full APPP in the study area in the near future.

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