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Prioritization of Accident Black Spots in Kerala

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Abstract :- Road safety is a matter of great concern worldwide now a days. India had highest road traffic accidents in the world with more than 1, 50, 000 deaths annually. Every day 3300 deaths and 6600 serious injuries occur on the road in the world. There is 3% (i.e. INR 55,000 Crore) Gross Domestic Product (GDP) loss per year due to accidents in India. The location in a road where the traffic accidents often occur is called an accident black spot. The rectification o accident black spot is the major step in reducing road accidents and fatality. This study focus on finding out a suitable technique for prioritizing accident black spots. The study methodology adopted includes identifying the black spots by weighted severity index, accident density and by method of ranking and severity index. The priority list of accident black spots of Kerala was prepared by considering the severity index which indicates the vulnerability of a spot to accident. In this study, the additional parameter selected is the distance to the nearby trauma care facility availability near the accident black spots based on 'golden hour' concept of emergency medicine.

Keywords:- *Accident Black Spot, Weighted Severity Index, Accident Density, Method of Ranking and Severity Index, Golden Hour.*

I. INTRODUCTION

Highways form the economic backbone of the country as well as an integral part of every human being. As the facilities of roadways increase, the population of vehicles also increase there by resulting in increased number of traffic congestion and accidental casualties. However the road infrastructure is insufficient to handle the increased number of vehicles resulting in increased road accidents. Road safety is one of the most important problems the society recently. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents globally. If current trends continues, road accidents will be third leading contributor of Disease and injury by 2020 which will be a burden globally. In Kerala, there were 336 major accident locations during the year 2016 there are 4287 fatalities, 39420 road accidents and 44108 grievous injuries (Kerala Police, 2016). There were 12 fatalities happened on the State per day. In Kerala more than half of the road accident victims are in the age group of 20 to 55 who are the key wage earning and child raising age group. The loss of the main bread winner and head of household due to death or disability is catastrophic which leads to lower living standards and poverty. Traffic accident or road crash is mainly caused due to road environment, condition of vehicles using the road system and the skills, concentration and physical state of road users[2]. High number of road crashes on a location indicates the presence of more causative factors contributing to crashes. The identification of the factors that contribute to road accidents helps to improve the performance of highway system.

Locations where accidents are historically concentrated is termed as an accident black spot. Rectification of defects in black spots is the primary step in reducing accident as well as fatality rate. The accident black spot treatment works may be divided into three phases such as targeting black spots on the road network, prioritizing the black spots to treat with safety improving measures and before and after studies of the effect of treatment. Better methods are necessary for the identification and prioritization of black spots for treatment to rectify the defects. But limited studies have explored the methods for prioritizing the accident black spots. Hence, this study explored the application for prioritizing the accident black spot based on the importance of major defects noticed in a particular location which leads to fatality. The treatment of accident black spots as well as the availability of better medical facility in the vicinity can reduce fatality rate due to major/grievous accidents to a great extent. So in this study, along with human error and infrastructure deficiency, additional parameter selected was the availability of medical facility during major accidents. This is a prime factor to reduce accident rates during grievous injuries.

II. BRIEF OVERVIEW OF LITERATURE

Reference [5] analyzed the accident data based on classified volume count data i.e. the number of vehicles per day passing at different locations was found out and remedial measures for selected spots were suggested. Reference [3] carried out a study based on four year accident data of the study area. To identify the accident prone locations the total stretch was divided into smaller sections of 5 km each. Total accidents and accident severity value has been used to rank the accident prone locations. A field study has been also conducted to compare the analysis with field results. Reference [10] hinted that the accident-prone locations can be identified by ranking the parameters based on their severity and calculating the severity index. In the study, physical survey was carried out at the actual location selected for study. The parameters which caused maximum number of accidents

were assigned minimum weight age. The summation of the weight ages were calculated to find out the total severity. The severity Index was then calculated by adding the weightages of each parameter present divided by the total severity. So separate investigation necessary to nullify the effect of parameters to reduce the severity of accidental black spots.

Navneet et al. (2014) carried out a study based on road accident data of four years and conducted a study in which total accidents and accident severity value has been used to rank the accident prone locations. To identify the accident prone locations the total stretch was divided into smaller sections of 5 km each. A field study has been conducted to compare the analysis with field results. A researcher with different approach, Reference [7] conducted study to identify the accident black spots on National Highway-4 and to suggest remedial measures. The project concentrates on infrastructure errors and their combination with other types. For finding out various causes of accidents, different methodologies adopted and to find out remedial measures, international journal papers were referred. Methodology adopted includes collecting the secondary data from respective authority, conducting physical survey (primary data) and analyzing them by method of ranking and severity index, accident density method, weighted severity index. Locations appearing in all the three methods were termed as black spots. Further corrective measures were suggested.

III. METHODOLOGY

The study area is Kerala State. Three years (2014-2016) accident data, details of accidents such as date, time, place, severity of crash, type of crash and reason for crash recorded in the First Information Report (FIR) of major accident spots from police department is necessary for the study. The methods used for identifying and prioritizing accident black spots are:

A. *Weighted Severity Index (WSI)*
B. *Accident Density and*
C. *Method of Ranking and Severity Index.*

A. Weighted Severity Index

In this method, the weighted severity index is calculated based on the classification of accident as fatal (K), grievous injuries (GI) and minor injuries (MI). Location having highest severity index value is ranked first followed by the rest. The concept of this method is that the fatality or injury crashes are given greater weightage than property damage-only crashes. The weightages are given based on socio-economic values. WSI is a dimensionless value indicating the hazardousness of a spot.[7]

WSI = 41K + 4.1GI + MI
Where WSI – Weighted Severity index
K - Number of fatalities
GI - Number of grievous injuries
MI -Number f minor injuries

In WSI formula, a fatal accident has been given 10.02 times more weightage than grievous accident (4<<41). Also minor accident has been given unit coefficient (1<<41). The locations with WSI value greater than or equal to 41 is usually termed as a black spot. More data is required to compare the grievous and minor accidents with fatal accidents while calculating WSI. WSI value is independent of traffic volume, population, number of registered vehicles or length of road. The weightage points 41, 4.1 and 1 were assigned based on updated Road User Cost Study (RUCS) carried out by Ministry of Road Transport and Highways (MoRTH).The major limitation of this method is that the number and type of accidents are only considered.

B. Accident Density

The accident density is the number of accidents per unit length for a section of highway. Sections with more than a predetermined number of accidents are classified as highly accident prone locations. The steps considered for calculation of accident density are:

- Unit length is taken as 500 m.
- Predetermined number of accidents is calculated as average number of accidents that have occurred during the period considered for study per unit length.

Both, weighted severity index and accident density methods seem to be inadequate because the factors causing accidents are not considered or evaluated. In order to reduce crashes the defects of the road causing accidents and the reason for increase in number of fatalities needs to be analysed. So calculation of severity index by the method of ranking was also considered in this study for prioritization of accident black spots.[7].

C. Method of ranking and severity index

- *Method of ranking*

In this method, the vulnerability of a particular spot to accidents is determined and the most predominant parameter causing accidents is found. It is based on logical analysis. The parameter occurring most frequently is given the top rank and the parameters that have occurred less frequently are given lower ranks. Ranks given to different parameters are applicable to a particular study area only.[7].

In this study, the cause of accident at black spot locations was collected by questionnaire survey and infrastructure deficiencies were identified by Road Safety Audit (RSA). For RSA, the checklist for specific audit from IRC SP: 088-2010 is used.

- *Severity index (SI)*

Severity index denotes vulnerability of a particular spot to accidents. Severity (β) is calculated by adding respective weightages of parameters indicating defects for a particular chainage /stretch[7].
The severity index, SI = (β/ ΣW) x 100

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where, ΣW= w1+w2+…+wn
β- Total weightage of defects in a particular accident black spot.
ΣW-Total weightage of defects considered.
n- Number of parameters indicating defects.

The severity index bench mark value denote whether the accident prone location is a black spot. Severity index bench mark denotes the value above which the corresponding spots are black spots.

Severity index bench mark =100-[(ΣW5/ ΣW) x 100]
where,
ΣW5- Summation of weightage assigned to top 5 parameters
ΣW-Weightage of all parameters

The major accident prone location whose severity index value falls above the severity index bench mark are black spots. The priority list of black spots for treatment can be prepared based on severity index value which is calculated based on the factors causing accidents. After preparing the priority list of black spots the remedial measures can be suggested for the treatment of accident black spots.

IV. RESULTS

➢ *Weighted Severity Index*
The weighted severity index of the accident black spot locations calculated are shown in figure 1.

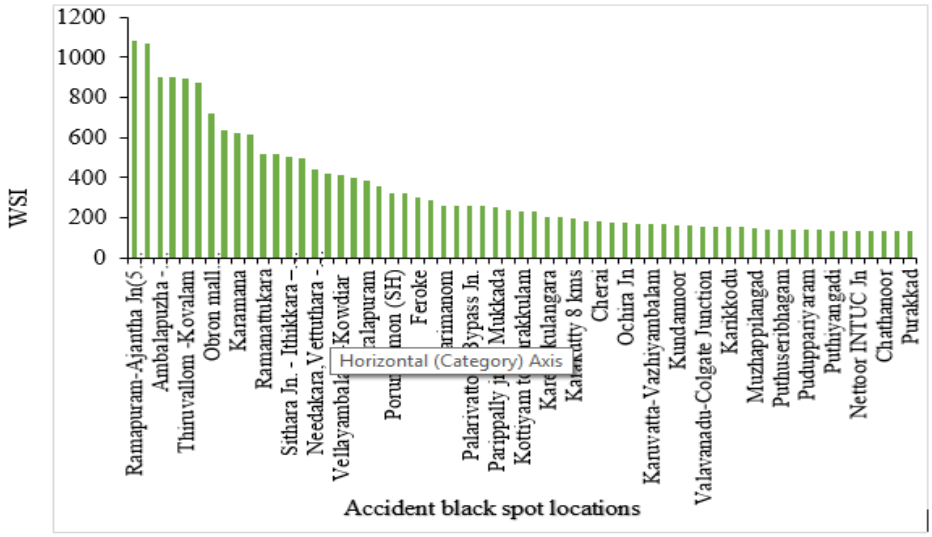

Fig 1:- Weighted Severity Index of Accident Black Spots

➢ *Accident Density*
The accident density of accident black spot locations were calculated and is shown in figure 2.

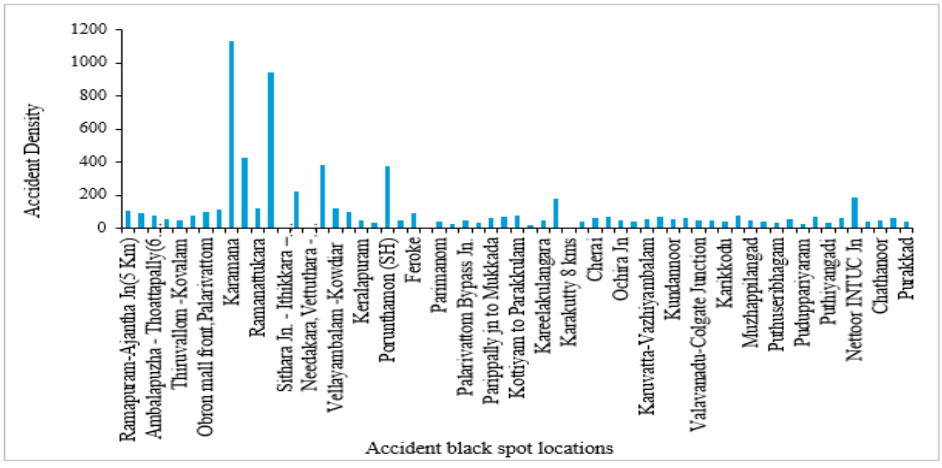

Fig 2:- Accident Density of Accident Black Spots

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The calculation of weighted severity index and accident density shows that there 61 accident black spot locations in Kerala. The limitations of the method are:
(a) Prioritization based on number and type of accident only.
(b) The factors that causing accidents were not considered or evaluated.
(c) To reduce crashes, the evaluation of the factors causing accidents and the
(d) Black spots which lacks safety measures must be given top priority for treatment works.

So method of ranking and severity index considered for analysis and prioritization.

➢ *Method of Ranking and Calculation of Severity Index*

The study area selected were four Districts of Kerala such as Thiruvananthapuram, Kollam, Alappuzha and Ernakulam. There are 61 accident black spots identified in Kerala. These districts were selected for study because 48 number of black spots of Kerala spans in the study area i.e. more than 75% accident black spots are in the study area. So these 48 numbers black spots were studied in detail for preparing priority list based on severity index by method of ranking. In the method of ranking, the parameters that cause accidents on highways needs to be ranked based on the frequency of occurrence. The parameters were identified and given weightage based on questionnaire survey and road safety audit.

Five questionnaire sheets distributed at each accident black spot and collected opinion. The questionnaire includes ten questions in which people gave information about the exact location of crash they witnessed and also the type, nature, time and condition of road at the time of accident. The collected opinion was tabulated for ranking the parameters causing accidents. Road safety audit of 48 number of black spots was also carried out using the check list of Road Safety Audit manual (IRC SP: 88-2010). Human error was identified as the major cause of accident in almost all black spot locations. The other defects such as absence of traffic control devices, edge drop, curves without road furniture, unscientific dividers and absence of object hazard markers, advertisement boards distracting driver attention etc. The defects noticed were selected, ranked and were assigned weightages based on questionnaire survey and road safety audit is shown in Table 1.

Rank No.	Parameter	Weightage given
1	Human error (Human error such as over speed/ violation of lane discipline /unmannered overtaking)	10
2	Absence of traffic control devices	9
3	Lack of pedestrian crossing facilities	8
4	Lack of night visibility	7
5	Lack of trauma care/medical facility in terms of occurrence of accident	6
6	Unscientific dividers	5
7	Edge drop	4
8	Advertisement boards affecting the reaction time of driver	3
9	Presence of curves	2
10	Parking on side affecting visibility	1

Table 1:- Parameters selected and assigned weightages

The distance to nearest trauma care availability was the additional parameter selected. The term 'Golden Hour' (golden time) in emergency medicine, refers to the first hour after a traumatic injury. During this golden hour prompt medical treatment will prevent death and survival rates drop off after 60 minutes. This is why it is very important in taking medical facility as a parameter during major accident. (Source: Journal of Medical Emergency Service). Considering the above fact the lack of trauma care/medical facility is given a total weightage of 6. Distance to the nearest medical facility was given classified weightage based on time to reach there after grievous injury because lack of proper availability of medical facility will cause more fatalities. Classified weightages were assigned based on medical facility available within 10, 20,30,40,50 and 60 minutes after grievous is shown in Table 2.

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Sl. No	Distance to medical college hospital (Km)	Weightage
1	0-5	1
2	5-10	2
3	10-15	3
4	15-20	4
5	20-25	5
6	>25	6

Table 2:- Classified weightage based on distance to nearby multi-specialty hospital/ medical college hospital

The Severity Index of accident black spot locations were calculated which is shown in Figure 3. The limiting value of severity index i.e. the severity index bench mark is 27.27.

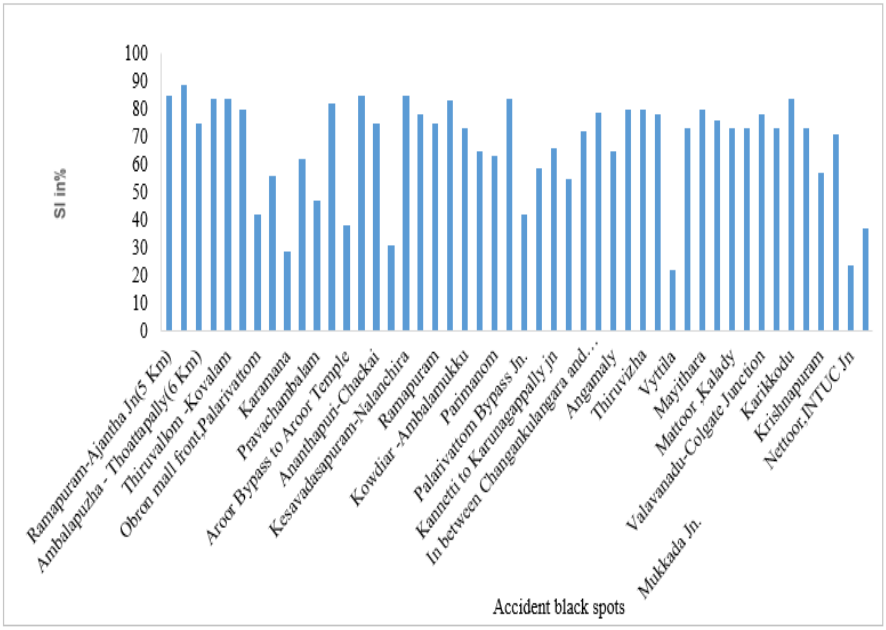

Fig 3:- Severity Index of Accident Black Spots

The severity index of 48 black spot locations calculated were tabulated and the priority list of black spots were prepared.

V. SUMMARY

From the study it can be concluded that the weighted severity index value is calculated only after the occurrence of accidents. So this method is helpful in identifying accident black spots only. The accident density is calculated based on the accidents taken place and hence this method is helpful in identifying the accident prone nature of a stretch. Severity index value helps in finding the factors causing accidents. So severity index method can be used for prioritization of accident black spots to carryout rectification works. This also helps to find the nature of rectification works to be carried out on each accident black spot locations.

VI. CONCLUSION

From the study it can be concluded as that:

- Severity index method is an effective method to prioritize accident black spots as it pin points the nature of rectification works to be carried out on each locations.
- Carrying out rectification works based on severity index is helpful in preventing fatal and grievous accidents.
- Severity index value also helps to identify the short term, midterm and long term measures to be carried out to rectify defects on black spot locations as per the availability of funds.

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