Abstract— Road accidents are increasing every year worldwide. The Global status report on road safety 2015, reflecting information from 180 countries, indicates that worldwide the total number of road traffic deaths has reported at 1.25 million per year. Some locations have a high accident potential but not have a high accident numbers. Some locations have high accident number but fatality is less. So remedial measures for road safety firstly needed on the locations where fatality is more not number of road accidents. Road accident cause huge losses to the economy in the shape of vehicle damage, property damage, charges involved in hospitalization and treatment etc. identification of hazardous locations in a road network is an important task for improving road safety. This paper presents review on development of a methodology for ranking road safety hazardous locations.

Key words: Road Network, Identification of Hazardous Locations

I. INTRODUCTION

According to official statistics 141,526 persons were killed and 477,731 injured in road traffic crashes in India in 2014. The total number of road accidents increased by 2.5 per cent from 4,89,400 in 2014 to 5,01,423 in 2015.Road accidents are become a big problem of worldwide. Accidents cause huge losses in the economy in the form of economy loss like property loss, vehicle damage and cost of treatment of victims. Road accidents also give pain, grief and suffering to the victims as well as those who care for the victims. Therefore, there is an urgent need to reduce the number and severity of road accidents by implementing road safety methods at hazardous locations in the road network. Road safety methods proposed to be apply on hazardous locations. Thus, Identification of road safety hazardous location is most needed. Further, it is generally not possible to implement all remedial measures identified due to limited budget available for road safety improvement. Hence, it is needed to rank the hazardous locations so that depending on the available budget, the hazardous locations can be treated. This paper present review on various methodologies for ranking or identification of hazardous locations.

II. REVIEW OF LITERATURE

Some critical study relevant to ranking of road safety hazardous locations is given below.


It reported that a road is decomposed in three sections in this study like; straight section, curve section and intersection. Safety factors are identified in each road sections. A methodology is developed for ranking road safety hazardous locations which is based on relative importance of safety factors.

The weighted sum of the condition rating and weight of safety factor is used to calculate a Safety Hazardous Index (SHI) for a road section. Road sections with the highest values of SHI are identified as the most hazardous locations.

Ranking of road safety hazardous locations is evaluated by determination of safety hazardous index at straight sections, curve sections and intersections.

1) Safety Hazardous Index

\[ \text{SHI} = \sum \text{WSF} \times \text{RSF} \]

Where,

- SHI = Safety Hazardous Index
- WSF = Weight of Safety Factors
- RSF = Condition Rating of Safety Factors

B. (HSIP, 1981)

These manual presents seven procedures to identify road safety hazardous locations two of them are given below.

1) Accident Rate Method

This method combines the accident frequency with the volume of traffic. Highway systems of 10,000 miles or less is applicable.

Accident rate at a spot in accidents per million vehicles can be identify by this formulae

\[ R_{sp} = \frac{A_{(1,000,000)}}{(365)(T)(V)} \]

Where,

- \( R_{sp} \) = Accident rate at a spot in accidents per million vehicles
- \( A \) = Number of accidents for the study period
- \( T \) = Period of study (years or fraction of years)
- \( V \) = Average Annual Daily Traffic (AADT) during the study period

Deficiencies of Accident Rate Method

1) May over represent hazard at locations with very low traffic volumes.
2) Requires additional data (traffic volumes) compared to the frequency method.
3) Does not account for accident severity.
4) Does not give consideration to locations with a high potential for accidents, but with no past accident experience.

2) Accident Severity Method

Accident severity methods are used to identify & rank high-accident locations. Formula used in this method is.

\[ \text{EPDO} = 9.5(F+A) + 1.5(B+C) + \text{PDO} \]

Where

- \( F \) = Number of fatal accidents
- \( A \) = Number of A-type injury accidents
- \( B \) = Number of B-type injury accidents
- \( C \) = Number of C-type injury accidents
- \( \text{PDO} \) = Number of PDO accidents
- \( \text{EPDO} \) = Equivalent property damage only

Deficiencies of Accident Severity Method:
1) The severity of an accident is highly dependent on many factors which are unrelated to the highway location (i.e., age and health of passengers, type of vehicles involved, use or non-use of seat belts).
2) Does not consider locations with a high Potential for accidents

This study presents an auditing based methodology to determine the hazardous locations. A Rural road is investigated by decomposing it first into six elements, and then into safety factors corresponding to each element. The elements are: straight segments, horizontal and vertical curves, bridges, tunnels, merges and intersections, and side road land use. For each element, a list of intervening safety factors is also described. In the designed questionnaire the relative importance of the safety factors affecting road safety were stated by road safety experts. The relative contribution of the elements to the safety of a road segment is determined using the Analytical Hierarchy Process (AHP) via a system of weights which are suggested by an expert panel. Subject to a consistency test of the expert responses, AHP determines the weight of elements. The resulting weights specified by the experts of a developing country for rural road network were presented. Conducting a road safety audit, a score is assigned to each factor. The experts used in the early stage of the method could be deployed as auditors; nevertheless, the auditors could be different. The weighted sum of the scores called Safety Index (SI) is introduced as a measure for ranking hazardous locations. Road segments with the lowest values of SI are identified as the most hazardous locations.

D. (Sobhani A. and Sarvi M. et. al, 2011)
This study explained the development of a simulation based modelling approach to assess the safety performance of road locations. The developed framework consists of two main parts. The first part of the framework is to estimate number and severity of conflicts using micro simulation model. Inputs into this part of the framework are the geometry and traffic characteristics of the road system. The output of the first part of the framework is the characteristics of the simulated serious conflict. The second part of the framework is the measurement of potential injury severity of each simulated conflict. This part of the framework consists of two main models. The first model is the driver reaction model. This model determines the driver reaction in conflict based on the simulated conflict characteristics.

E. (Mandloi D. and Gupta R et. al, 2003)
Road safety is a major concern in the present situation. There are many steps required to achieve the road safety measures. This paper presents a method by which the accident-prone locations on roads, commonly termed as accident black spots, can be identified. The methodology incorporates a model which implements prioritization of roads for accident occurrence, followed by analysis using a Geographic Information System (GIS). The GIS software used for this purpose is ARCVIEW 3.1. The various factors required for the analysis are modeled using Microsoft Visual Basic6.0 and Microsoft Visual C++6.0 software packages.

The main advantage of using this approach for identifying accident black spots on roads is that it requires very less additional data other than the road network map. So the results obtained from this model can easily be used for planning road safety measures. Also these can be supplemented with the results obtained by using other approaches. Moreover the results can act as a quick guideline for road network planners and the authorities concerned with accident mitigation measures. However the accuracy of this model highly depends on the way in which the road network is digitized. The road geometry can be inferred incorrectly if it is not properly digitized. Even the selection of proper resolution during r targeting and suitable check length for curvature analysis can affect the results.

F. (Mustakim F. and Yousof I. 2008)
Identification and prioritization of accident black spot location were carried out by using the following Methods:
- Ranking accident point weightage
- Ranking of the top ten accident sections

The Accident Prediction Model, Multiple Linear Regression Method presented in this study is

\[ \ln(\text{APW}) = 0.0212(\text{AP}) + 0.00007(\text{HTV}) + 0.75(\text{GAP}) + 0.0020(\text{PS}) \]

Where,
- APW = Accident Point Weightage
- AP = Number of Access Points per Kilometer
- HTV = Hourly Traffic Volume
- Gap = Amount of time, between the end of one vehicle and the beginning of the next in second.
- 85th PS = 85th percentile speed

G. (Rokade S., and Gupta S. et.al., 2010)
Accident Prediction Model is developed using Multiple Linear Regression Analysis for Bhopal city based on the factors influencing road accidents. The dependent variable used in the model is Number of Accidents (Y). The independent variables used in the model are traffic volume, lighting condition traffic sign etc.

\[ \text{Number of Accidents} = 426.339 + 707.9X_2 + 2222.88X_3 - 534.83X_4 + 912.17X_5 + 1552X_6 - 1425.07X_7 + 1631.94X_8 \]

Where,
- Y = Number of Accidents
- X₁ = Road cross-section dimensions,
- X₂ = Traffic volume,
- X₃ = Speed,
- X₄ = Road shoulder width,
- X₅ = Lighting conditions,
- X₆ = Traffic signs,
- X₇ = Traffic signals

III. CONCLUSIONS
There is an alarming requirement to reduce the number and severity of road accidents by implementing remedial methods for road safety at hazardous locations in the road network. Further, it is generally not possible to implement all remedial measures identified at every hazardous location due to limited budget available. Hence, it is required to assign priority to the hazardous locations so that depending on the available budget, the hazardous locations can be treated. All the studies for identification or ranking of hazardous locations using generally two steps, the first step are data collection and data preparation for analysis. The
second step is data analysis using statistical or simulation analysis methods. Those methods improve the understanding of the safety performance of roads. Which of them some studies does not require accident data, it works on the present condition and weight of various safety factors of road. Comprehensive road accident data is rarely available so a method which does not require road accident data is more effective for identification of road hazardous locations.

REFERENCES


