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Road Safety Audit for Selected Rural Roads of Aravalli District

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Abstract: In most regions of the world, the epidemic of road traffic fatalities is on the upsurge with over 1.2 million people die every year due to road crashes and about 50 million suffer nonfatal injuries. Motor vehicle population has grown at a compound annual growth rate (CAGR) of 10 per cent 2000-2009, fuelled by a rising tide of motorization. Concomitantly, traffic risk and exposure have grown. During the year 2010, there were around 5 lakh road accidents, which resulted in deaths of 134,513 people and injured more than 5 lakh persons in India. These numbers translate into 1 road accident every minute and 1 road accident death every four minutes. The loss to the Indian economy due to fatalities and accident injuries estimated at 3% of GDP in 1999-2000 is particularly severe as 53.1% of road accident victims were in the age group of 25 to 65 years in 2010, with pedestrians, bicyclists and two wheelers, who comprise the most unprotected road users, accounting for around 40% of all Fatalities.
The present study focuses on Road Safety Audit at Rural area of Aravalli district Gujarat India. This research aims at developing an expert system that can serve as a diagnosis knowledge-based system of traffic-safety condition at rural roads due to the principles of RSA. The expert system deals with the database of safety auditing examination according to checklists extracted from the program of RSA for rural roads in Aravalli.
The goal of this study is to better understand rural roadway accident causes in Aravalli, in order to help and find cost-effective solutions for reducing the frequency and severity of crashes on rural two-lane roadways. To achieve such a goal, traffic accident data, roadway geometric data, traffic volume data, traffic control data, and related land use data from study routes are collected and analysed A total of five-year data from 2010 to 2014 are collected from multiple sources, including the Police Department, roadway video image data (from electronic media), and geographical information systems (GIS) data retrieved from Road and Building Department(R&B).
Results from the statistical analyses and accident risk models will provide valuable insights in developing cost-effective solutions against roadway segment and intersection accidents on Aravalli District's rural roads.

Keywords: RSA- Road Safety Audit.

I. INTRODUCTION

A) General

Road safety audit is the systematic checking of the safety aspects of new/existing highway and traffic management schemes, including modifications to existing layouts. The main aim of road safety audit is to ensure that all new road schemes operate as safely as practicable from the beginning and to reduce future problems.

B) Objective of the Study

- To develop a model/relationship for identification of safety influencing parameters in minimizing likelihood accident rate on selected section of rural road network.
- To examine safety features adopted in the selected section of rural road and find out deficiencies in the road network which led to accident and safety hazards to road users.

C) Scope of the study

- This study will audit route network of selected study area for road safety.
- With the suggested measures, if they will be implemented then
  1. Accident rate may reduce,
  2. Fatality of accidents may be reduced,
  3. Road accident injuries may be reduced,
  4. Rate of loss of property may be reduced.

II. REVIEW OF LITERATURE

Jain et al. (2011) have studied the study aims to evaluate road safety audit of a section of four-lane national highway (NH)-58 and will focus on evaluating the benefits of the proposed actions that have emanated from deficiencies identified through the audit process. After conducting RSA, it is found that trucks are parked on highway which reduces the effective width of carriageway and creating traffic hazards to high speed moving traffics. Unauthorized median openings were found which should be immediately closed. Missing road and median markings to be done and speed signs should match with speed. Access and service lanes are also deficient which requires immediate improvement. The most vulnerable road user (VRU) i.e. Pedestrians and cyclists facilities near habitation are lacking and needs to be facilitated on priority.
Mishra et al. (2013) have carried out RSA of Selected Stretch From Umreth Junction To Vasad Junction , their study area consists of cities and villages such as Umreth, ode, Khambolaj, Sarsa, Vehrakhadi and Vasad is located in Anand district of Gujarat state. The whole stretch is located in Anand and Umreth Talukas of Anand district, following data of study area corridor were collected:

1) Road Inventory and Surrounding Land Use Pattern.
2) Classified Volume Count.
3) Accident Data from Police Stations

Wang et al. (2008) has shown that traffic accidents cause loss of life and property. Proper identification of accident causal factors is essential for composing countermeasures against traffic accidents and reducing related costs. However, two-lane rural roads have distinctive roadway characteristics compared with other types of roads. In order to find cost-effective countermeasures and prioritize roadway safety improvement plans for two-lane rural roadways, a better understanding of the relationship between accident risk and respective characteristics is necessary.

The Manual on Road Safety Audit *IRC: SP: 88-2010* is based on the research study sponsored by the Ministry of Road Transport and Highways to the Central Road Research Institute (CRRI), New Delhi.

This Manual is aimed at decision-makers, engineers and technicians throughout the Indian roads sector, irrespective of whether they work at National, State, District or Local level. It is intended for all those who can and should contribute to improve safety on Indian roads. It provides procedures for applying quality assurance to road projects, from the standpoint of road safety. The methodology is known as 'road safety audit'. When its application becomes widespread, it is expected to make a significant contribution to the prevention of accidents on roads.

III. METHODOLOGY

Accident data collection

The data collection of the accidents is primarily done by the police. Motorist accident reports are secondary data which are filed by motorists themselves. Table 3.1 shows the format of accident detail obtained from the Police department.

The data to be collected should comprise all of these parameters:

1. General - Date, time, and person involved in accident, classification of accident like fatal, serious, and minor.

2. Location - Description and detail of location of accident.

3. Details of vehicle involved - Registration number, description of vehicle, loading detail,
Vehicle defects.

4. Nature of accident - Details of collision, damages, injury and casualty.

5. Road and traffic condition - Details of road geometry, surface characteristics, type of traffic, traffic density etc.

6. Primary causes of accident - Details of various possible cases (already mentioned) which are the main causes of accident.

7. Accident cost - Financial losses incurred due to property damage, personal injury and Casualty.

Table 1. Format of accident detail of Police department.

Sr. No.	Date	Time	Place	Collision	Type of vehicle involved	No. of death	No. of injured person

Accident Rate per Kilometre:

On this basis the total accident hazard is expressed as the number of accidents of all types
per km of each highway and street classification.

$$R = A \div L$$

Where, R = total accident rate per km for one year,
A = total number of accident occurring in one year,
L = length of control section in km.

Accident involvement Rate:

It is expressed as numbers of drivers of vehicles with certain characteristics who were
involved in accidents per 100 million vehicle-km of travel.

$$R = (N \times 100000000) \div V$$

where, R = accident involvement per 100 million vehicle-km of travel, N = total number
of drivers of vehicles involved in accidents during the period of investigation and V =vehicle-km of travel on road section during the period of investigation

Accident Rate based on vehicle-km of travel:

The accident hazard is expressed as the number of accidents per 100 million vehicle km
of travel. The true exposure to accident is nearly approximated by the miles of travel of
the motor vehicle than the population or registration.

$$R = C \times 100000000 \div V$$

Where, R = accident rate per 100 million vehicle km of travel,
C = number of total
Accidents in one year and V = vehicle km of travel in one year.

Types of volume measurements

Since there is considerable variation in the volume of traffic, several types of measurements of volume are commonly adopted which will average these variations into a single volume count to be used in many design purposes.

1. Average Annual Daily Traffic (AADT)

The average 24-hour traffic volume at a given location over a full 365-day year, i.e. the total number of vehicles passing the site in a year divided by 365.

Road inventory

Highway features determine road traffic safety, besides road capacity and economic traffic operations. Highway features are visible elements of highway and consist of various components. So, the safe and efficient operation of highway is governed by road geometric parameters, traffic control devices, lighting system of the stretch, composition of traffic, drainage condition, junction layout, parking facilities, cross drainage structures and the adjoining land use of the stretch. Road geometry comprises parameters like road width, shoulder width, footpath, height of embankment, sight distance, horizontal curvature, vertical curvature, etc. The traffic control devices comprise signs, markings, delineators, crash barriers, guard rails, etc.

Relation between road condition and accident rate

A study in India has revealed the following relationships.
Bombay- Poona road
AR (1) = -0.1526 + 0.0216 RF + 0.0031 CV+ 0.4793 J
Some Selected Roads in India
AR (3) = 0.2171 + 0.002884 CV + 0.4126 J - 0.3447 W + 0.001274 Q_{ADT}
In the above equations
AR (3) = personal injury accident rate per million vehicle km per year
AR (1) = accident rate in number per km per year
RF = rise and fall in m/km
CV = curvature in Deg. /km
W = pavement width in m
J = number of junctions per km
Q_{ADT} = total volume in terms of vehicles (all type) per day.

IV. Study Area and Data Collection

Aravalli district is a district in the state of Gujarat in India that came into being on August 15, 2013, lies at 24.0283° N, 73.0414° E in western India becoming the 29th district at 197 metres (646 feet) above sea level on the banks of the Mazum river, in north Gujarat state. The district has been carved out of the Sabarkantha district. The district headquarters at Modasa. Figure 4.1 shows the location of Aravalli district in the map of Gujarat.
The district consists of Modasa, Malpur, Dhansura, Meghraj, Bhiloda and Bayad t alukas of former Sabarkantha district. Of these, Meghraj, Malpur and Bhiloda are tribal dominated talukas. The district includes 676 villages and 306 village panchayats with a total population of 1.27 million and is the most literate (74%) tribal district in Gujarat.

Route map of Modasa to Tintoi: length 20.8 Km.

Table 2. Accidents Detail of Modasa to Tintoi

Summary of Accidents detail of Modasa to Tintoi			
Year	*Total No. Of Accidents*	*Fatal*	*Non-Fatal*
2009	26	9	17
2010	21	8	13
2011	18	7	11
2012	12	5	7
2013	14	7	7
2014	6	2	4

Fig. 1. Summary of Accidents Detail of Modasa to Tintoi

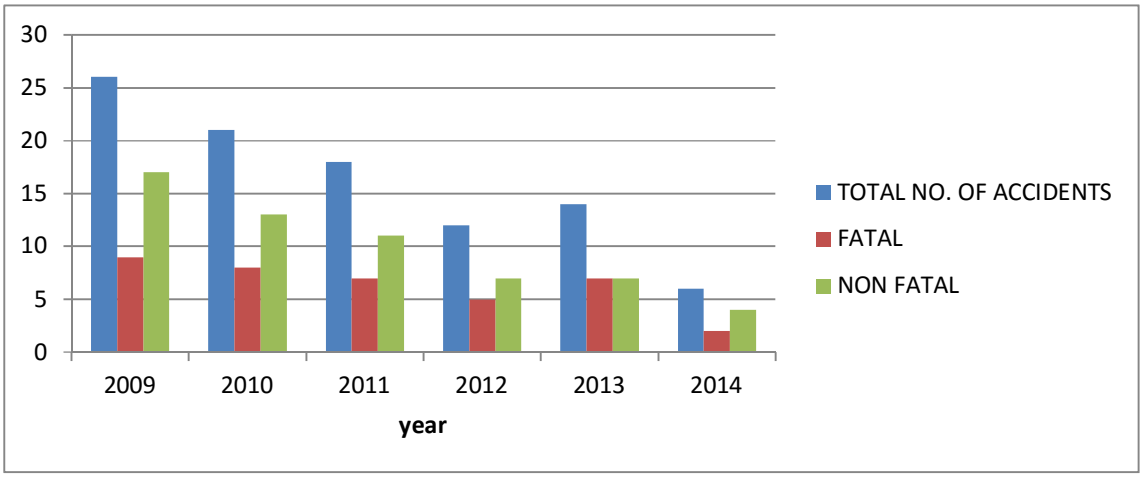

Fig. 2. Summary of Fatal Accidents Detail of Modasa to Tintoi

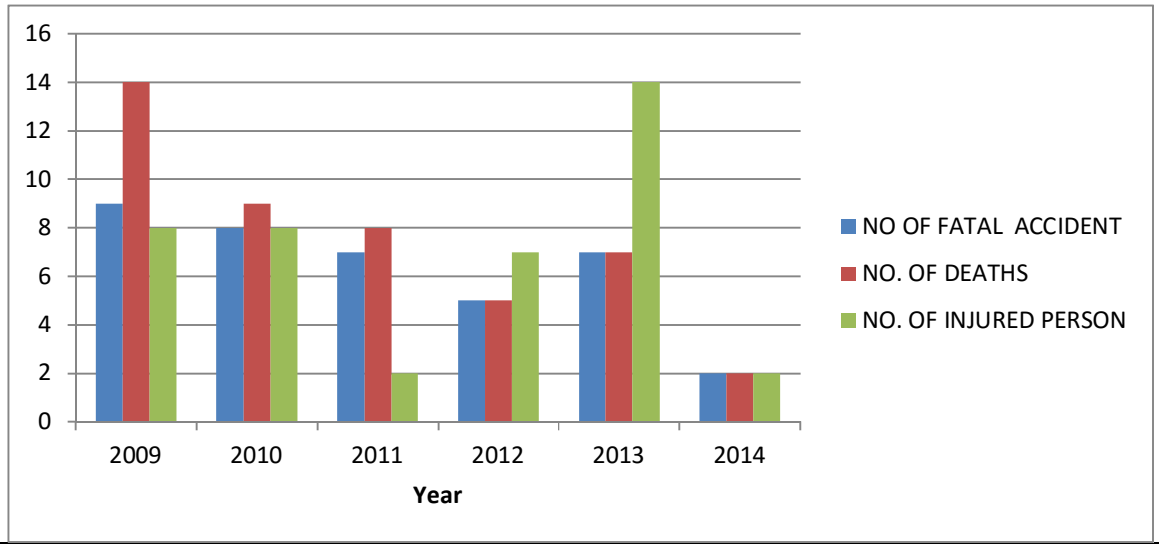

Fig. 3. summary of non-fatal accidents detail of Modasa to Tintoi

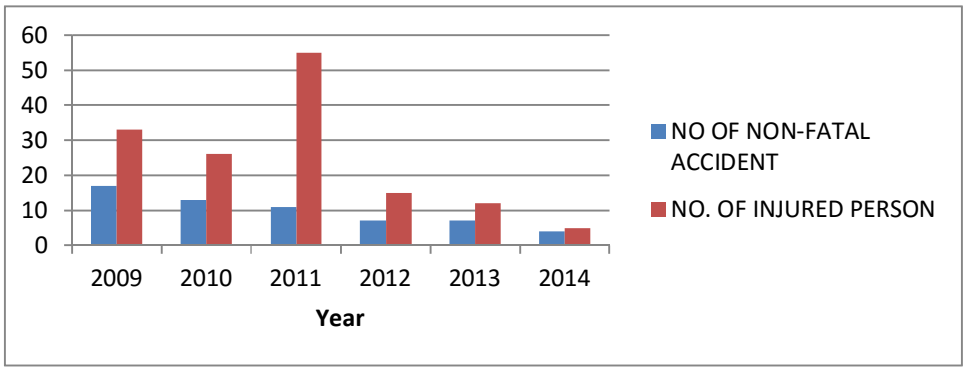

Fig. 4. Accident with respect to type of vehicle and type of collision Modasa to Tintoi

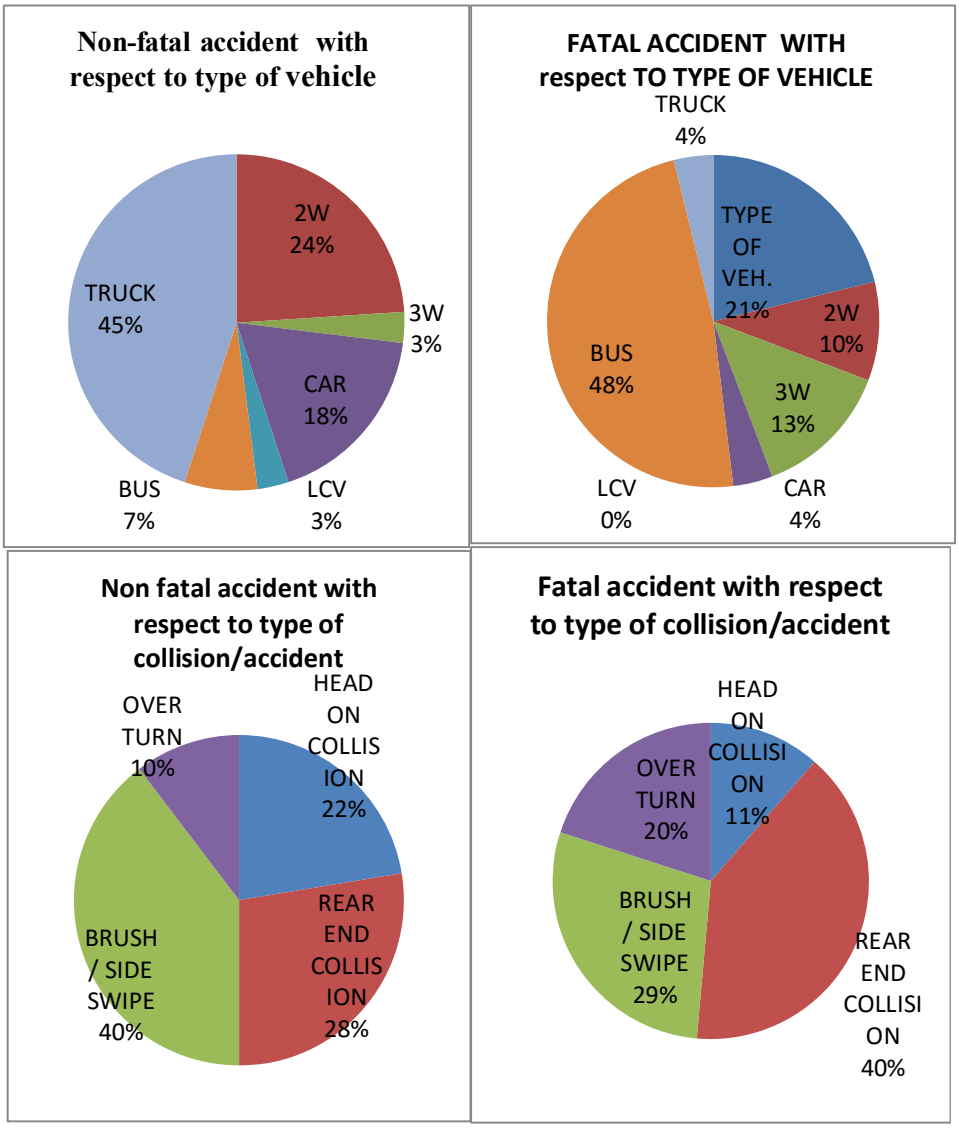

Table 3. Functional Inventory of Modasa To Tintoi Road

SECTION NO. (CH. IN KM)	*R & F /KM*	*CV/KM*	*AVG.WIDTH*	*JUNCTION/KM*	Q_{ADT}	*NO. OF ACCIDENT PER YEAR PER KM*
1 (0.0 TO 3.0)	0.97000	16.66667	14.12000	1.33333	3846	0.22222
2 (3.0 TO 6.0)	8.51000	26.00000	15.30000	1.00000	3689	1.55556
3 (6.0 TO 9.0)	7.66000	30.33333	14.13000	1.00000	3553	0.72222
4 (9.0 TO 12.0)	7.99000	24.33333	14.44412	1.00000	3527	0.83333
5 (12.0 TO 15.0	3.18500	9.33333	14.44912	1.66667	3970	0.88889
6 (15.0 TO 18.0)	6.07300	6.66667	14.44635	1.33333	4252	1.22222

A study in Aravalli district has revealed the following relationship

$$AR = -12.5585 + 0.1158\,RF + 0.0149\,CV + 0.5769\,W + 0.6406\,J + 0.0008923\,Q_{ADT}$$
$$R^2 = 1$$

AR = Accident rate in number per km per year
AF = Rise and Fall in m/km
CV = Curvature in Deg. /km
W = Pavement width in m
J = Number of junctions per km
Q_{ADT} = Total volume in terms of vehicles (all type) per day.

V. CONCLUSION:

Study represents that rise and fall of road, width of pavement, No. of junction and degree of curvature impacted accident rate and they are the main factor for causing road accident on selected route. From them no. of junction is most impacted factor for accident and the traffic volume impact for accident is negligible due to level of service of road is class A.
If the improvement in rise fall of road, curvature and junction location then accident rate may automatically decrease, which is feasible for selected route of Aravalli district.

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