OPEN ACCESS
Saudi Journal of Civil Engineering
Abbreviated Key Title: Saudi J Civ Eng
ISSN 2523-2657 (Print) |ISSN 2523-2231 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: http://saudijournals.com/sjce/

Original Research Article

Evaluation of Road Safety Audit on Existing Highway by Empirical Babkov's Method

A. Anandraj*, S. Vijayabaskaran

Assistant Professor, Saranathan College of Engineering, Trichy-madurai road Panjappur, Venkateswara Nagar, Edamalaipatti Pudur, Tamil Nadu 620012, India

DOI: 10.36348/sjce.2020.v04i06.001 | **Received:** 30.07.2020 | **Accepted:** 06.08.2020 | **Published:** 13.08.2020

***Corresponding author:** A. Anandraj

Abstract

Road Safety Audit (RSA) is a formal procedure for assessing accident potential and safety performance of new and existing roads. RSA is an efficient, cost effective and proactive approach to improve road safety. It is proved that RSA has the potential to save lives. RSA appears to be an ideal tool for improving road safety in India, as basic and accurate data on accidents have yet to be collected. The study aims to evaluate Road Safety Audit of a section of four - lane Madurai - Chennai, National Highway (NH) - 45 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 in deficit which requires immediate improvement. The most Vulnerable Road User (VRU) i.e. pedestrians and cyclists facilities near habitations are lacking and needs to be facilitated on priority.

Keywords: Road Safety Audit, Safety Analysis, Four-Lane National Highways.

INTRODUCTION

Road Safety Audit (RSA) is defined as "the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team [1, 2]. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users [3, 4]." Road safety audits differ from conventional traffic safety studies in two key ways: road safety audits are often pro-active investigations, rather than reactive investigations of sites with histories of complaints or poor safety performance, and the investigation team is independent from the staff that is designing the project or maintains the road [5-8].

Road Safety in India

In India, at present there is no formal requirement for road safety audits to be undertaken. However, India has also started realizing the importance of road safety audits. It is because of Ministry of Road Transport and Highways sponsored the project on "Development of Safety Audit Methodology for Existing Roadway Sections" to Central Road Research Institute in April 2002 [9, 10].

The National Highway Authority of India entrusted CRRI to carry out RSA of engineering design for construction packages under TNHP (8 packages) and GNTRIP (7 packages) on NH-2. The total length of these 15 packages was about 900 KM which was the longest road project for which RSA has been carried out in the world. Also, first RSA was carried out again by CRRI in 2000 on Indore Bypass. It is understood that the entire NHDP will be subjected to RSA as part of its implementation. However it is to be recognized that RSA are to be under taken all types of roads [11-15].

OBJECTIVE

The objective of the study is

- To identify accident prone areas on the road from visual studies and FIR (First Investigation Report).
- To study the effect of roadway geometrics.
- To study the traffic conditions on the road stretch.
- To develop a relationship between accident rates and various factors causing accidents.

SCOPE

The scope of the study is to

- Reduce accidents on road network.
- Reducing severity of accidents.
- Reducing the need for costly remedial work.

RSA METHODOLOGY

For carrying out RSA in a systematic and impartial way, it is essential to follow a rigorous procedure. The four key elements which makes RSA most productive are:

- Selections of projects for audit
- Role of different organization in RSA
- Team selection
- Audit organization

There are three basic forms of road safety audit,

Audit of an existing road or road network

To check a road or a network for consistency, to make sure that a road user does not encounter unexpected road safety issues.

Audit of a road works project at various stages of completion:

- Feasibility stage, or project scoping, where the general nature of the project is determined.
- Preliminary design stage, where alternate courses of action for the project are analysed, and selected or discarded.
- Detailed design stage
- Construction stage, to make sure work zone traffic controls are protecting road users and construction workers.
- Post construction stage, to make sure the completed project is performing as intended.

Thematic audit

Thematic audits are focused on particular aspects of a road. They may be used to investigate road safety issues brought up by road user groups, or audits conducted to support a land development application.

Stages in RSA

There are five stages at which a road safety audit can be conducted, regardless of the size and nature of a project. They are:

- The feasibility stage.
- The draft design stage.
- The detailed design stage.
- The pre-opening stage and
- An audit of an existing road.

Area of Interest

The road selected for the study is from Viralimalai to Panjappur stretch on MADURAI - CHENNAI Highway (24 km). The accident analysis is done from four years data. The V. F. Babkov's analysis is done by collecting geometric features of the road [16].

Fig-1: Viralimalai to Panjappur Stretch on Madurai - Chennai Highway (24 km)

Influence of Road Conditions on Traffic Safety

Road related factors are the most important factors which determine accident risk. Elements of road geometry require careful design and take longer time to implement. The most important element of the roadway which affects safety is cross-sectional elements, sight distance considerations, horizontal curve radius, grade and pavement surface characteristics. Every road consists of a combination of separate sections differing in these factors. The relative probability of a road accident on any section can be appraised by a summary accident rate calculated as the product of the separate relative accident rates characterizing the worsening of traffic conditions in comparison with a two-lane road having a roadway width of 7.5m, paved (or stabilized) shoulders and a non-skid pavement due to their influence of separate elements of the horizontal alignment, profile, cross-section and roadside strip [17].

Collection and Analysis of Accident Data

Selected road stretch was divided into number of sub stretches measuring approximately 2000 meters. At each sub-stretch details of following road geometrics were also collected. 8 hours volume count was conducted at 2 locations of the stretch on a weekday covering both peak and off peak hours of a day. Floating car method survey was conducted to find the speed at every kilo-meter of the stretch. The accident particulars pertaining to the study stretch was collected from the respective police stations. The accident data form as prescribed by IRC has been prepared to collect the necessary information such as date, time, location, whether the accident was fatal, vehicle damage and injured [18].

Analysis of Accident Data

The date, time, approximate place, types of vehicles involved etc., are entered in the First Information Report (F.I.R) and details are recorded in case diaries. In order to analyse accident data, it was found that the details were not recorded in standard format and police FIR lacked the important engineering aspects like Nature of Accidents (Head-On, Rear-End etc.,) Type of location (Mid Block, Intersections, Curves, Bridge etc.). Therefore, micro level analysis is not possible. The pedestrians are most affected by accidents in this road. The pedestrian safety is very low. The data regarding the road accidents have been collected for a period of four years, i.e. 2016 to 2019 from the Traffic Police Station. Kilometer-wise distribution of accidents is shown in Table-1 and Graphical representation of kilometer-wise accidents are presented in Figure-2 [19].

Table-1: Kilometer-Wise Distribution of Accidents

Distance (km)	Vehicle Damage	Injured	Fatal	Total	Percentage
0 – 2	15	25	4	44	20.28%
2 -- 4	10	13	1	24	11.06%
4 – 6	14	21	2	37	17.05%
6 – 8	18	6	4	28	12.90%
8 – 10	5	8	1	14	6.45%
10 – 12	13	7	8	28	12.90%
12 – 14	11	6	6	23	10.60%
14 – 16	3	8	0	11	5.07%
16 – 18	1	6	1	8	3.69%
18 – 20	4	3	2	9	4.15%
20 – 22	12	8	4	24	11.06%
22 – 24	1	3	1	5	2.30%
Grand Total			**217**		

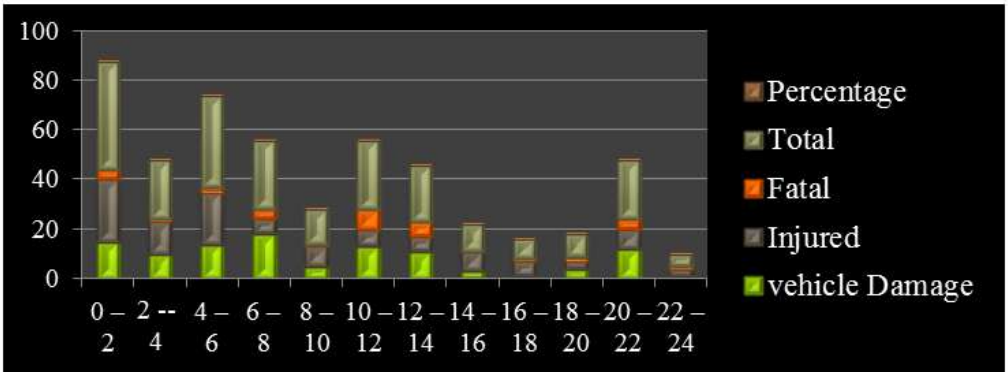

Fig-2: Kilometer-Wise Distribution of Accidents

Accidents which occurred during the study period, i.e. 2016 – 2019, are arranged Year-wise, Month-wise and Hour-wise. It is observed that more number of accidents has occurred in the year 2018. To understand the causes of accidents, it is important to examine Kilometer-wise trends of the accidents, which will help to identify the accident prone stretches of the roads network [20].

Relation between Roadway Width and Relative Accident Rate

- A wide divided road provides enough space for overtaking operation whereas a narrow road hinders that operation.
- A careless manoeuvre on such stretches leads to accidents.
- To know the effect of roadway width on relative accident rate, a plot between them was obtained and the corresponding trend was shown in Figure-3.

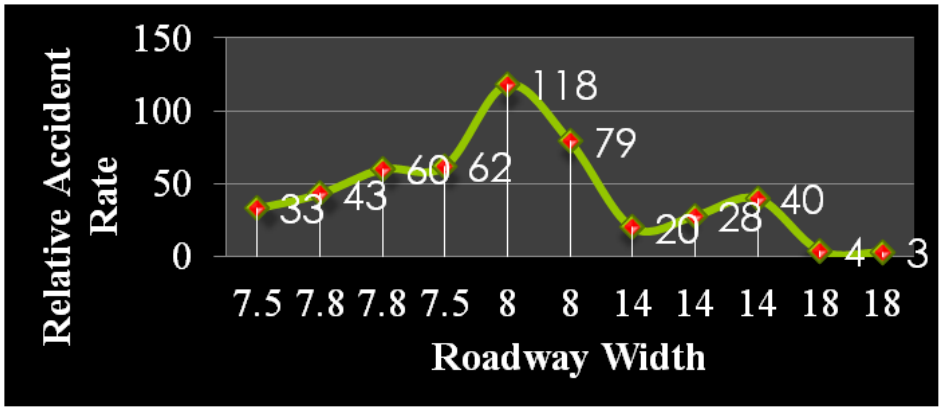

Fig-3: Effect of Roadway Width on Relative Accident Rate

Relation between Shoulder Width and Relative Accident Rate

- Shoulders are needed for parking stopped vehicles in India.
- They are used for crossing and overtaking the vehicles.
- To study the effect of width of shoulder on relative accident rate a plot of shoulder width and relative accident rate is obtained and is presented in Figure 4.

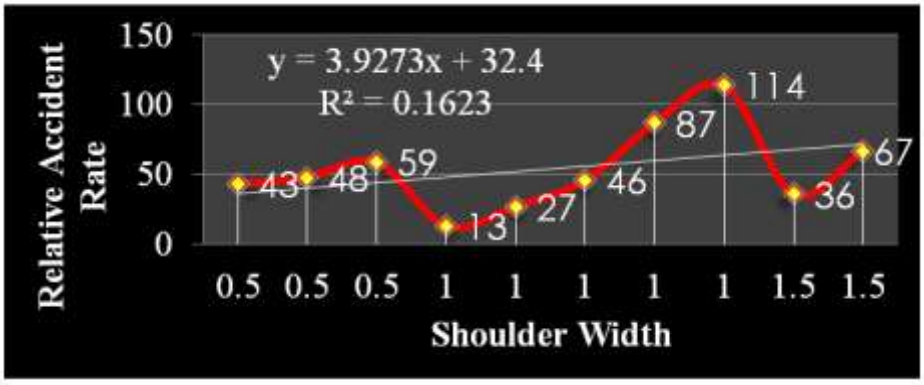

Fig-4: Effect of Width of Shoulder on Relative Accident Rate

Relation between Sight Distance and Relative Accident Rate

- Sight distance can be for (i) safe stopping and (ii) overtaking.
- An insufficient sight distance is most frequently the cause of accidents in passing through intersections.
- To know the effect of sight distance restrictions on relative accident rate, a plot between them was obtained is shown in Figure-5.

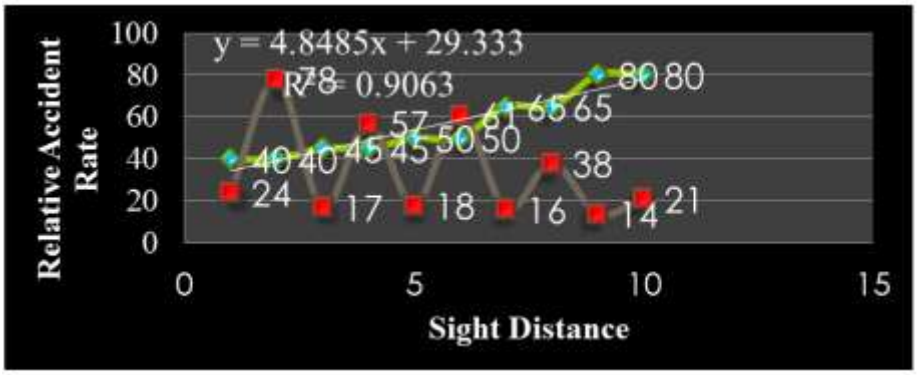

Fig-5: Effect of Sight Distance on Relative Accident Rate

Comparison by Babkov's Method

Accidents are characterized by Location, Day and hour, Daylight conditions, Severity, Vehicle type, Volume of traffic, Shoulder width, Sight distance, Kind of road intersection and other conditions. Considering all data, a filtering process was done, deleting accidents that presented at least one of the following issues:

$$K_{ac}=K1\ K2\ K3\ldots K14$$

Where,

K1 = Volume of traffic, vehicles/day
K2 = Roadway width, m
K3 = Shoulder width, m
K4 = Radius of horizontal curve, m
K5 = Radius of horizontal curve, m
K6 = Sight distance, m
K7 = Difference between width of roadway on bridge and on approach road, m
K8 = Length of straights, KM
K9 = Kind of road intersection
K10 = At-grade intersection with minor road at volume of traffic on main road, vehicle/day
K11 = Sight distance ensured at an intersection from the minor road, m
K12 = Number of traffic lanes
K13 = Distance from buildings to roadways, m
K14 = Characteristics of pavement /Co-efficient of friction.

Using the accident data along with the data related to road geometrics and traffic characteristics, analysis was done to find the summary accident rate for every kilo-meter of the stretch using the Babkov's partial severity factors. The actual measurements of the geometric, traffic and other physical features along the road stretch and the summary accident rate values obtained from the analysis are given in Table-2.

Table-2: Babkov's Partial Severity Factors Tabulation

K1 = Volume of traffic, vehicles/day	1.8											
K2 = Roadway width, m	7.5						14					
K3 = Shoulder width, m	0.8			0.8		1.0	1.0		1.2		1.2	
K4 = Radius of horizontal curve, m	1.0											
K5 = Radius of horizontal curve, m	1.6			0.6							1.4	
K6 = Sight distance, m	2.25			2.0							2.0	
K7 = Width of bridges	1.0											
K8 = Length of straights, KM	1.0											
K9 = Kind of road intersection	1.5											
K10 = At-grade intersection with minor road	1.0											
K11 = Sight distance at an intersection	1.0			1.65		1.1	1.1		1.1		1.0	
K12 = Number of traffic lanes	2						2					
K13 = Distance from buildings to roadways, m	5.0						7.5					
K14 = Characteristics of pavement	1.3											
Summary Accident Rate	14.35	88.13	14.16	16.46	24.76	51.23	61.23	47.49	35.27	35.27	52.36	113.54
Actual Number of Accidents as per FIR	44	24	37	28	14	28	23	11	8	9	24	5
Kms.	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24

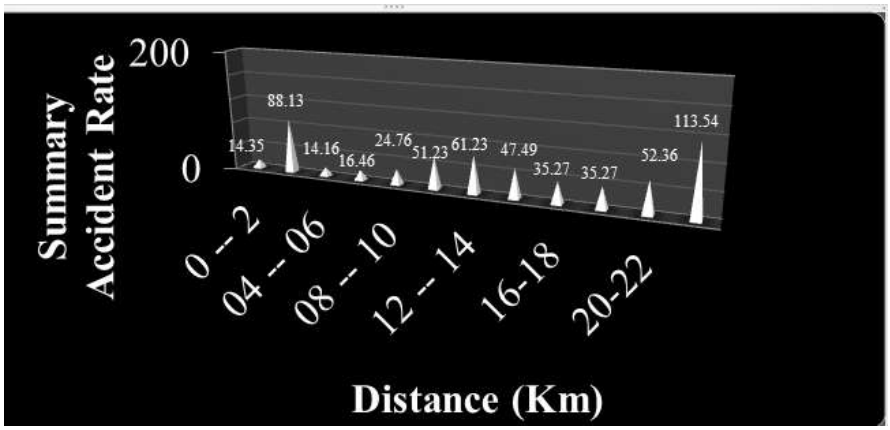

Fig-6: Accident Rate Analysis by Babkov's Method

CONCLUSION

Based on the data collected and analysed in the chosen highway stretch following points are concluded,

- More number of accidents has occurred during 2018.
- No definite trend is observed with month wise distribution, the accidents have occurred all through the year.
- Majority of accidents have occurred during 8 a.m. to 12 p.m. and 4 p.m. to 6 p.m. of the day and it is difficult to explain the particular trend.
- It was observed that most of the accidents are occurring between 1st to 4th Kilometers, 10th to 14th Kilometers and 20th to 22nd Kilometers.

These stretches needs geometric improvement, pavement resurfacing etc.

The study stretch has very low pedestrian safety. The accident reasons for low pedestrian safety are:

- Sight distance problem.
- Improper foot paths.
- Driving vehicles on footpath.
- People standing on the road near bus stand.
- Foliage on the median.
- Non – abidance of traffic rules.

REFERNCES

1. Austroads. (1994). Road safety audit. Sydney: AUSTROADS National Office.
2. CEC. (1997) Promoting road safety in the EU: The programme for 1997-2001, COM (97)131 final, Brussels: Commission of the European Communities.
3. Crafer, A. (1995) Review of road safety audit procedures. Occasional Paper. London: Institution of Highways and Transportation.
4. Danish Road Directorate. (1993). Safety audit handbook. Copenhagen: Danish Road Directorate.
5. EEC. (1985). Council Directive on assessment of the effects of certain public and private projects on the environment, (85/337/EEC), Official Journal of the European Communities, L 175, 40.
6. ETSC. (1996). Low-cost road and traffic engineering measures for casualty reduction, Brussels: European Transport Safety Council.
7. European Parliament and Council of the European Union. (1996). Community guidelines for the development of the Trans-European transport network. Decision No. 1692/96/EC, Official Journal of the European Communities, L 228, 39.
8. FGSV. (1988). Richtlinien für die Anlage von Strassen, Teil Knotenpunkte, Abschnitt 1 (RAS-K-1), Köln: Forschungsgesellschaft für Strassen unde Verkehrswesen.
9. GDV. (1997). Euska, Zeitgemässe Verkehrssicherheitsarbeit. Bonn: Institut für Strassenverkehr - Gesamtverband der Deutscher Versicherungswirtschafte.
10. Kanellaidis, G. (1999). Aspects of road safety audits. *Journal of transportation engineering*, *125*(6), 481-486.
11. IHT. (1996). Guidelines for road safety audit. London: Institution of Highways and Transportation. ITE (1994) Informational report: road safety audit. Committee 4S-7, July 1994. Washington DC: Institute of Transportation Engineers.
12. Jordan, P. W. (1994). Road safety audit: the AUSTROADS approach. *Road and Transport Research*. 3(1), 4-11.
13. Machu, C. (1996). A new approach to improved road safety: safety checking of road infrastructure in Proceedings of the FERSI International Conference "Road Safety in Europe", Birmingham, September 1996. VTI Konferens. 7A(4), 19-28.
14. OECD. (1994). Environmental impact assessment of roads. Paris: Organisation for Economic Co-operation and Development.
15. Ogden, K. W., & Jordan, P. W. (1993). Road safety audit: an overview. In the proceedings of the Pacific Rim Transport Technology Conference, Seattle, July 1993.
16. Schelling, A. (1995). Road safety audit, the Danish experience. In the proceedings of the FERSI International Conference Road Safety in Europe and Strategic Highway Research Program, Prague, September 1995. VTI Konferens. 4A(4), 1-8.

17. Surrey County Council. (1994). Road safety audit: an investigation into casualty savings. Kingston upon Thames: Surrey County Council.
18. Transit New Zealand. (1992). Accident countermeasures: literature review. TNZ Research Report Number 10. Wellington: Transit New Zealand.
19. Wegman, F. C. M., Roszbach, R., Mulder, J. A. G., Schoon, C. C., & Poppe, F. (1994). Road safety impact assessment: RIA. Report R-94-20. Leidschendam: SWOV Institute for Road Safety Research.
20. Wrisberg, J., & Nilsson, P. K. (1996). Safety audit in Denmark - a cost-effective activity. Copenhagen: Danish Road Directorate.