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Evaluation of Road Safety Audit for Existing National Highway

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Abstract - In order to accomplish diverse societal goals like reducing travel time and increasing safety, transportation engineers have a constant struggle in planning and operating the transportation system. The exponential rise in India's economy and consumer habits has led to an unparalleled rise in road traffic and vehicular traffic, resulting in more hazardous conditions on the country's highways.

Keywords - Road Safety Audit, Four-Lane National Highways, HCM/IRC, Identification of Safety Influencing Parameters

I. INTRODUCTION

The problem of road safety is multifaceted on many levels. More specifically, it encompasses everything from infrastructure development to transportation planning to health care delivery to urban land use policy. The scope of the project includes both road and vehicle engineering and the provision of medical services for trauma patients (in the event of a crash). Road safety is a joint duty of the government and a wide range of civil society organisations, including non-governmental organisations (NGOs). When it comes to road safety audits, an independent, certified examiner reports on the project's accident potential and safety performance and it is defined as a "formal evaluation of a current or planned road or traffic project" (AUSTROADS, 1994). The Indian Road Safety Manual (2010) describes a Road Safety Audit as "a systematic approach for analysing accident potential and safety performance in the supply of new road schemes, the improvement, and rehabilitation of existing roads, and in the maintenance of existing roads".

According to the above definition, a Road Safety Audit is a systematic approach used by an independent audit team to evaluate existing or new roads during the stages of planning, design, construction, operation, and maintenance in order to achieve accident-free roads and improve overall safety performance.

The objectives of this paper are as follows:

a) To develop a methodology for Road Safety Audit for Four-Lane National Highways.
b) To examine safety features adopted in the selected section of four-lane National Highway-48 and find out deficiencies in the road network which led to accident and safety hazards to road users.
c) To identify the need of alternate measures of traffic management to access the existing section with respect to the standard Indian Road Congress (IRC)/ Highway Capacity Manual (HCM).

II. LITERATURE REVIEW

Examining Prior Papers (Guozhu Cheng, Rui Cheng, Yulong Pei, Juan Han -2021) [1] This study examined the various methods and models for predicting and evaluating roadside accidents. Small-radius curves, heavy traffic, objects adjacent to the lane (such as poles and trees), narrow lanes, and narrow shoulders are the first five significant risk factors for frequent roadside accidents, and the first five significant risk factors for fatal roadside accidents are driver age 25 or 65, alcohol, speeding, failure to use seat belts, and heavy trucks, according to the number of times mentioned in the literature.

A group of researchers (Montoya-Alcaraz, Marco, Alejandro Mungaray-Moctezuma, Julio Calderón-Ramrez, Leonel Garca, and Cynthia Martinez-Lazcano, 2020) [2] By implementing and employing operational strategies, the goal of this research is to improve road safety by assessing and identifying the risks that lead to accidents among road users. As a result, road safety analysis must be a continuous process for those responsible for operating, designing, and building the road system.

Won-Joon Wang, Soojun Kim, Kyung Tak Kim, ChoongKe Lee, and Hung Soo Kim (2020)) are the members of this group. [3] On electronic maps (which include building and road name addresses), only those statistics that fall within the impact range of flood damage could be extracted and evaluated for flood risk in 31 Gyeonggi-do municipalities. As a result, the data obtained was more precise than that obtained using the previous methods.

(Shantajit, T., Kumar, C. R., & Zahiruddin, Q. S. -2018) (Shantajit, T., Kumar, C. R., & Zahiruddin, Q. S. -2018) [4] It is one of the leading causes of death, according to the WHO. There are many factors that

contribute to a traffic accident, including the environment, the vehicle, and the human being. Historically, road traffic accidents have been viewed as unavoidable, unavoidable, and unavoidable. As a result, everyone has a role to play in helping to reduce the number of traffic accidents.

The 2017 group of Shalini Kanuganti, Ruchika Agarwala, Bhupali Dutta, Pooja N. Bhanegaonkar, Ajit Pratap Singh, and Akshay Sarkar consists of the following members: [5] According to the findings of this study, the Pradhan Mantri Gram Sadak Yojana (PMGSY) roads in Rajasthan's Jhunjhunu district have the highest priority in terms of safety requirements. It is hoped that the methodology presented here will be useful to a variety of decision makers in determining the most critical roads for safety mitigation.

As of 2017, (Hitesh Kumar and Mrs. Monika) [6] Using FIR data, researchers set out to find high-accident spots on the road and develop statistical relationships between those spots and the various factors that contribute to their occurrence. Kaithal-Kurukshetra, Haryana, India, is the route chosen for the study. All of the data is used to identify the most dangerous areas.

Satyam P. and Mogre S.K. (2017, respectively) [7] H B Town SQUARE and the Jersey Milk Processing Plant on Bhandara Road in Nagpur, India, off of National Highway 53 and Asian Highway 46 are the focus of this study. The extent to which the total damage caused by accidents can be significantly and promptly reduced justifies the identification of countermeasures. It was recommended that the entire study area's coordinates be taken into consideration in the future in order to improve quality.

(Maru D. Freny - 2016) [8] Safety has become a major social concern in an era of ever-increasing mobility and transportation demand, necessitating a great deal of investigation and investigation. In developing countries like India, the number of accidents is steadily rising. Even if no one is killed or injured immediately, an accident can leave a person with long-term emotional scars and financial hardships. The findings of this study provide an accident and road safety scenario. Hazardous locations are ranked by the severity of an accident per kilometer. In order to prevent accidents on the entire stretch of road, this study analyzes accident scenarios.

the year 2016) (Singh, S.K. [9] This paper's primary goal is to examine the national, state, and metropolitan city levels of India's road accident statistics. Age, gender, month, and time all play a role in the distribution of road fatalities and injuries in India, according to the findings. The total number of road traffic deaths in India is expected to reach 250,000 by the year 2025 unless new efforts and initiatives are taken. Road deaths and injuries are on the rise, and urgent action is needed.

[10] Agra, Amritsar, Bhopal, Ludhiana, Vadodara and Vishakhapatnam are the six mid-sized Indian cities examined in this study. Overall, vulnerable road user deaths range from 84% to 93%, car occupant deaths range from 2% to 3%, and TST fatalities are less than 5 percent in each of the six cities. There are 2–3 and 3–5 times more MTW and TST passengers killed per 100,000 vehicles, respectively, than there are in cars. MTWs and cars pose a similar risk to society, with TSTs accounting for a slightly smaller risk, according to estimates of their association with fatal crashes. Data with a higher level of detail will be needed to verify some of these findings.

Research by Krunal Patel and colleagues (2015) [11] Analyses of deadly bus accidents in Bangalore, India are presented in this paper. Bicycle and pedestrian fatalities could be reduced significantly if low-floor buses with mechanical doors were used, as well as segregated pedestrian and bicycle lanes. This paper examines the underlying principles of safe road design and derives a general set of traffic safety principles with the goal of facilitating a functional comparison of driving assistance systems and infrastructure measures.

Michalski and Gaca (2014) [13] Management of road safety infrastructure aims to ensure the systematic identification and removal of road risks when roads are planned to be built and used. There are a variety of ways to manage road safety. Risk management processes are examined in relation to the lifecycle of a road structure.

(Agarwal, P. K. and Mehar, R. ,2013) [14] Analytical hierarchy process is used in this study to rank dangerous locations for road safety (AHP). The costs of hospitalization and treatment, as well as damages to vehicles and property, are enormous for the economy when it comes to road accidents. Implementing remedial measures at dangerous locations on the road network is essential in order to reduce the number of and severity of road accidents.

This study was conducted by Dongxiao Z. (2013) [16] A brief introduction to the originality and development of road safety audit in developed countries is provided firstly in the paper in order to provide some countermeasures for alleviating China's severe traffic safety situation on expressways Finally, China's current practice of road safety auditing on expressways is described. Road safety audits on expressways are also examined, and recommendations for promoting the use of road safety audits are offered.

According to Singh, Parida, and Jain (Jain et al. 2011, Jainet al. 2011) [18] Road Safety Audit of a section of four-lane National Highway (NH) 58 will be evaluated in the study, with a particular emphasis on determining whether or not the proposed actions, resulting from deficiencies discovered during the audit process, are beneficial. Trucks are parked on the highway, reducing the effective width of the carriageway and posing a hazard to oncoming fast traffic. A number of illegal median openings have been discovered, and they should be closed as soon as possible.

III. METHODOLOGY

An existing four-lane highway running under traffic demand is the subject of this chapter's safety study technique. The estimated yearly accident frequency for four-lane highways can be computed for a specific piece of road, intersection, or complete project. Figure 1 shows the flow chart for a method used to conduct a road safety audit on four-lane National Highways.

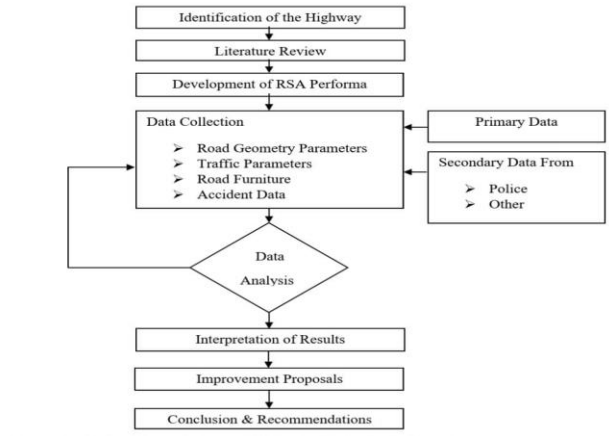

Figure 1: Flow Chart for Road Safety Audit Study Methodology

Projects to be audited

Road safety audit have been conducted on a wide range of projects varying in sizes, locations, types, and classifications. The types of projects that can be audited are categorized under the following headings:

- New expressways
- Major four-lane Highways projects
- Reconstruction and realignment projects
- Intersection projects
- Pedestrian and bicycle routes
- Signal upgrading
- Existing facilities
- Minor improvement projects
- Traffic Management Schemes (construction)
- Development schemes
- Maintenance works
- Municipal streets

Road Safety Audits Stages

It is possible to conduct an audit of a road's safety on both new and existing sections of road. RSA will help prevent the construction of accident-prone areas on new roads, and it will improve the safety of existing roads.

The complexity and level of effort of the audit process changes with each stage.

Stage 1: The feasibility stage

Feasibility studies are recommended for large-scale projects, whether they are in rural or urban areas, in order to have a direct impact on the selection of route, alignment, standards and cross section, number of junctions and their types, and potential hazards from roadside development, among other things. This stage includes a review of the first project/planning study. Figure 2 depicts the audit procedure in its first stage.

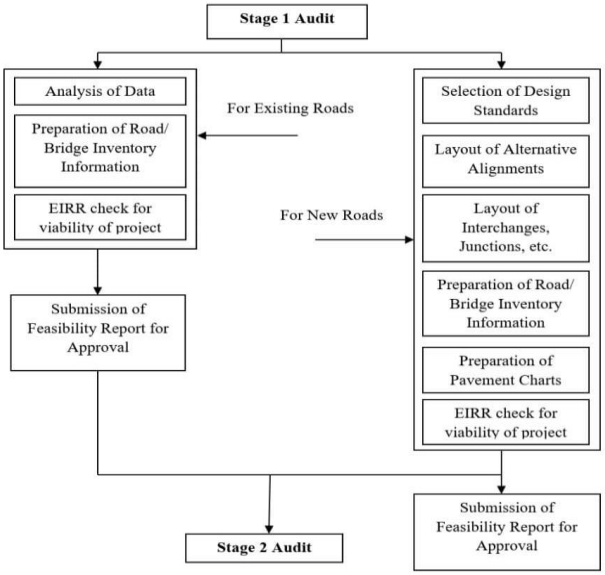

Figure 2: Steps Involved in Stage-1 Audit

Stage 2: The preliminary/layout design stage

The horizontal and vertical alignments, sight lines, junction arrangements, and cross-sections are all handled at this point. The preliminary design stage audit is conducted prior to the completion of the title boundaries in cases where land acquisition is required. On the recommendation of the preliminary design, this step of road safety audit is proposed. Figure 3 depicts the Stage 2 Audit procedure.

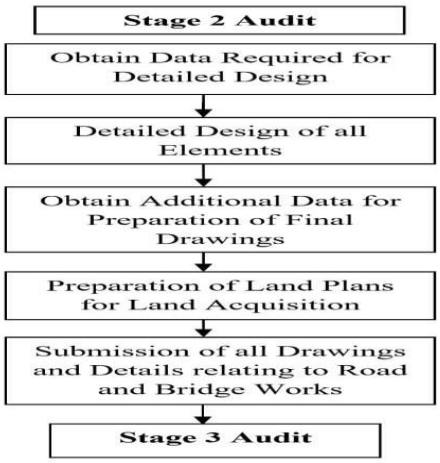

Figure 3: Steps Involved in Stage-2 Audit

Stage 3: Completion of detailed design

Prior to preparing contract documents, this RSA stage is recommended once the detailed design is complete to examine the detailed design of intersections, markings and signs scheme as well as side drains and embankment slopes, traffic signals and illumination features. Figure 4 depicts the Stage 3 Audit process

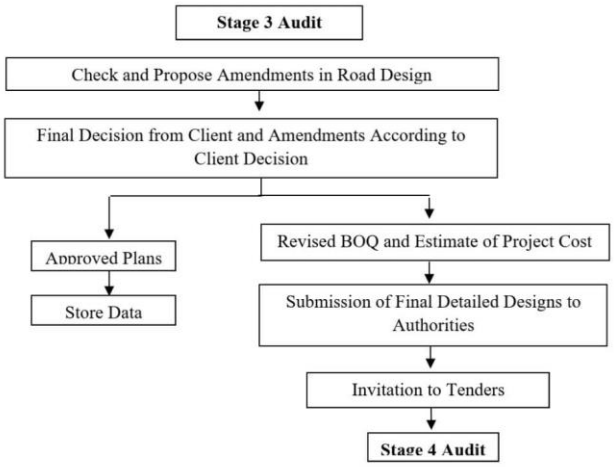

Figure 4: Steps Involved in Stage-3 Audit

Stage 4: During construction stage

At this point, the safety aspects of the Terminal Transition Zone, Work Zone, Approach Transition Zone, and Advance Warning Zone have to be examined. A review of the safety precautions in place for both construction workers and drivers on the road. At a building site, a look at the traffic management measures in place. The fourth stage. Figure 5 depicts the audit procedure.

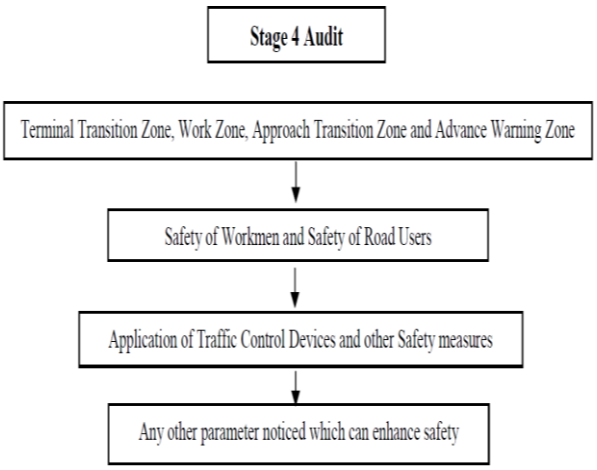

Figure 5: Steps Involved in Stage-4 Audit

Stage 5: The pre-opening stage

To ensure that the construction has addressed earlier audit concerns and to check for any hazardous conditions that were not apparent at the feasibility or design stage, a site inspection is made prior to opening (or immediately prior to practical completion, for a project that has been built with traffic passing through the site). Figure 6 depicts the audit process in its fifth stage.

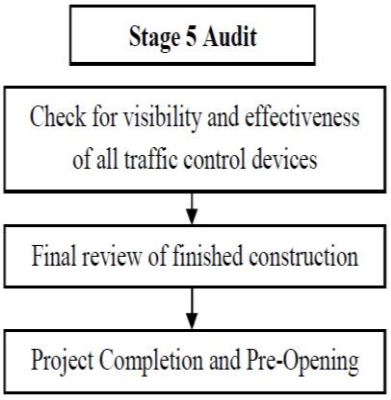

Figure 6: Steps Involved in Stage-5 Audit

Stage 6: Existing Roads (Monitoring)

Sections of the current road network are audited for safety. It doesn't matter how thoroughly the road was audited when it was first built; the route's use changes over time. Road safety issues including encroachment, ribbon development, or deterioration of road surfaces and traffic conditions can be discovered early on by regular audits of existing roadways. At this point, a safety audit involves an examination of how existing roadways are operated and maintained. Design speed,

visibility, and sight distance are just a few of the parameters that need to be monitored.

IV. STUDY AREA AND DATA COLLECTION

4.1 General

The section of NH-48 between Behror and Shahpura, the Road Safety Audit is conducted for this purpose. Accident and road inventory data are the sources of the research's data. NHAI assisted in the collection of accident statistics for the period from March-2019 to Feb-2020. (NHAI).

4.1.1 Description of Study Area

In order to identify the road safety needs for all road users, a road safety audit was conducted along the "Behror-Shahpura" stretch of 70 kilometres. Heavy and light trucks make up the majority of traffic on the roadway.

NH-48 is a National Highway of India that starts at Delhi and terminates at Chennai, traversing through seven states of India. It has total length of 2807 km (1744 miles).

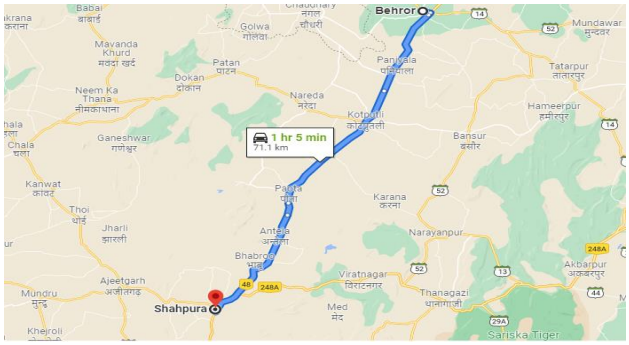

Figure 4.1 displays the route map for the selected section

4.2 Collection of Accident Data

Researchers analysed all of the accidents that occurred between March-2019 and Feb-2020, and they discovered that there isn't a single problem caused by the road's condition. Table 4.1 shows the stretch's accident data.

Table 4.1

Accident Data along Study Area

S. No.	Month	Total Accident	No. of Fatalities	No. of Injured persons	Severity Index (Number of persons killed per 100 accidents)	Number of Persons Injured per 100 Accidents
1	Mar-19	6	1	4	0	100
2	Apr-19	3	0	2	0	50
3	May-19	10	0	10	0	122
4	Jun-19	8	0	11	0	122
5	Jul-19	10	0	10	0	110
6	Aug-19	1	0	0	0	0
7	Sep-19	0	0	2	0	0
8	Oct-19	1	0	0	0	0
9	Nov-19	3	0	2	50	25
10	Dec-19	5	1	3	25	100
11	Jan-20	5	1	6	0	125
12	Feb-20	3	0	5	0	125
	Total	**55**	**3**	**55**	**5.45**	**879**

(Source: - NHAI)

Severity Index: Number of Persons Killed per 100 Accidents.

The Severity Index for this stretch ranged from 5.45 in March-November 2019 to 50 in November-December 2019. For the year 2018, Rajasthan had a Severity Index of 47.5.

V. ROAD SAFETY AUDIT-OBSERVATIONS & PROPOSALS

5.1 Observations and Proposals

Using data analysis, it was discovered that certain safety impacting characteristics were accountable for road accidents. There were some site-specific observations and proposals in the following sections.

5.1.1 Minor Junctions locations

The design of intersections and junctions should take into account the current and projected growth of traffic.

Observations: Most small junctions were found to be lacking in basic road markings like "Stop," "Directional Arrows," "Pedestrian Marking," and so on. Significant differences between minor and large roads were also discovered. RSA uncovered a number of issues with small junctions, including the following:

• There is no mention of the access roads that connect to the Project Stretch.

For merging and diverting small road traffic, there is no provision for acceleration and deceleration lanes.

There were 20 minor junctions that may be improved based on the current topographical situation and site observation in the study region. According to the table 5.1 below, the research area's identified minor junctions needing improvement have been included.

Table 5.1

Identified Minor Junctions for Improvements along the Stretch

S. No	Chainage	Side
1	142+400	LHS
2	144+800	LHS
3	145+100	LHS
4	147+500	LHS
5	149+400	LHS
6	154+400	RHS
7	156+100	LHS
8	160+200	RHS
9	162+400	RHS
10	165+400	LHS
11	169+300	LHS
12	172+500	RHS
13	176+750	LHS
14	180+100	LHS
15	188+100	RHS
16	197+300	LHS
17	205+650	RHS
18	207+800	RHS
19	209+800	LHS
20	212+700	LHS

Photograph showing the present condition of minor junctions along the Stretch are shown in figure 5.1.

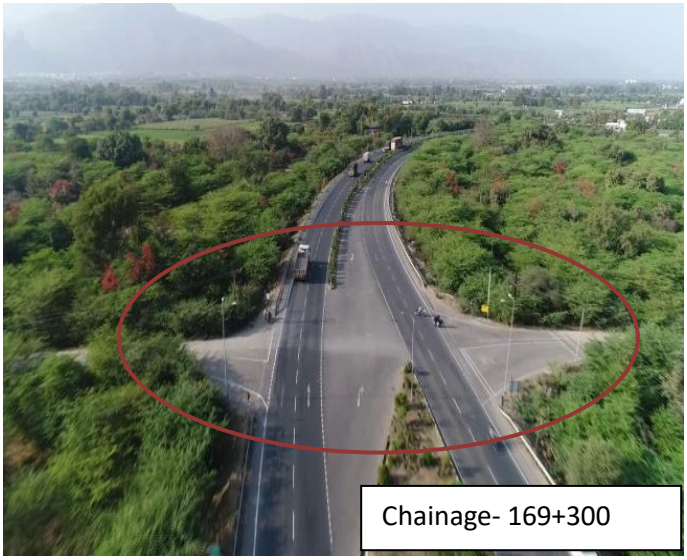

Figure 5.1: Deficiencies in Minor Junction along the Study Stretch

The above picture shows the deficiencies in minor junctions along the study stretch.

Remedial Proposals: A road hump of 10 metres from the road's edge is required by the International Road Code (IRC) in order to control the speed of cars approaching the main road. following ones should be considered:

- Stop and Give Way signs, as per IRC 67: 2012.
- Informatory sign boards for the identification of access roads, as per IRC 67: 2012.
- Speed Breakers on side roads as per IRC84: 2014.
- Proper Road Markings for turning Traffic, as per IRC 35: 1997.

According to codal regulations, the values from 5.2 to 5.4 are only for a limited number of situations, and are meant to aid comprehension. The other necessary IRC Codes are to be resorted to for the other specific field conditions.

5.1.2 Crash Barrier locations

The main purpose of the longitudinal roadside barriers is to protect vehicles from two types of roadside hazards: embankments and roadside obstacles.

Observations: Many crash barriers were found to be disconnected from the stiff concrete barriers during the audit. There was also a gap between the metallic crash barrier and the solid concrete crash barrier. Only the following places, which are indicated in the table 5.2 below, have been identified as having safety barrier problems.

5.1.3 Unauthorised Ramps

Observations: There were 18 unauthorized ramps on the LHS and 20 unauthorized ramps on the RHS, it was discovered. The majority of the illegal access points led to farms, houses, and roadside restaurants. Locations of Unauthorized Ramps throughout the Stretch were found in a Road Safety Audit Study. Table 5.3 following lists the locations of such ramps in groups of five kilometers.

Table 5.2

Number of Unauthorized Ramps along the Project Stretch

S. No	From(Km)	To(Km)	No. Of Ramps	
			LHS	RHS
1	142+000	147+000	4	6
2	147+000	152+000	3	2
3	152+000	157+000	4	2
4	157+000	162+000	2	3
5	162+000	167+000	3	5
6	167+000	173+000	2	2

Photograph showing Unauthorised Ramps along the Project Stretchare shown in figure 5.9 below.

Figure5.2: Unauthorized Ramps along the Study Stretch

Remedial Proposals: Except at major thoroughfares or traffic islands, the median opening for a U-Turn should not be used for private business purposes. There should be no more than a few of them.

5.1.4 U-Turns along the Study Stretch

The section was littered with illegal U-turns. People in the area were also found to be damaging median kerbs at a few points on this stretch because they were being used as unlicensed median openings. Some median openings did not include a storage lane or warning signage. The private business parties were helped by the discovery of a median opening. Figure 5.10 shows some of the photos taken along the Project Stretch that illustrate improper U-turns.

Remedial Proposals: It is permitted to offer additional openings of around 2 kilometres at intervals of 2 kilometres for U-turn and traffic diversion to one of the carriageways during emergency or substantial repair works, as stated by IRC:62.

5.1.5 Pavement Marking

The entire piece of road has lane and edge markings. For the safety of pedestrians, crosswalk markings were also present in town/village, market, and bus bay areas. Drivers will benefit from this by becoming more vigilant and being warned when their vehicles deviate from their lane.

5.1.6 Pedestrian Crossing facility

Observations: In the lack of pedestrian crossing facilities, the local populace devises their own unauthorised methods of crossing the roadways, which compromises the safety of other road users, according to a study.

Remedial Proposals: In accordance with IRC SP 88-2010, pedestrians must be allowed to cross the road at appropriate locations, and correct pedestrian crossing markings must be installed. Zebra crossings, whether at a signalised intersection or a pedestrian-activated signal, should be provided to ensure a safe and controlled type of crossing. These can be useful in decreasing pedestrian-vehicle traffic problems if used correctly.

5.1.7 Bus Lay Bays & Truck Lay Byes

Observations: Designed in accordance with IRC and MORT&H standards and specifications, each and every bus lay bay was constructed. Each bus stop had enough room for a smooth transfer. The majority of the bus lay-bys were located away from densely populated areas and intersections. There were no trucks in the parking lot. Both venues lacked food and service amenities. Near service stations, it was observed that most trucks were parked on the shoulder and the main road.

Remedial Proposals: It is recommended that two or three sets of informative sign boards be placed in front of bus and truck laybys to alert drivers to the upcoming facility and notify them of its presence. The illegal parking should be prevented since it was causing damage to the road and putting moving traffic at risk. In urban and semi-urban areas, the IRC: 70-1977 guidelines will be taken into account, as will the availability of land. At bus stops, you can count on a safe environment for passengers and drivers alike.

5.1.8 Lighting Arrangements

The town's flyovers and at-grade roadways have been outfitted with adequate illumination. There are high-mast lights in large cities and communities. In vehicular underpasses, lighting is also necessary below the slab. To ensure the safety of motorists and pedestrians alike at night, all of the highway's minor intersections should be outfitted with high mast lighting.

5.1.9 Highway Patrolling

All-night patrols should be provided by a pavement maintenance service in order to aid drivers. Traffic management, road safety, and basic First Aid should be taught to the patrol officers. The roadway environment should be constantly monitored by a dedicated Road Protection Police team.

VI. CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

When it comes to highway safety, the design fundamentals are critical. The driver's state of mind and physical condition can't be controlled, which makes the human component a key cause of accidents. The highway engineer can't do anything about drunk driving or the failure to wear a seat belt, and he can't do much to help drivers make better decisions at junctions either. However, a well-designed geometric layout will assist manage traffic speeds and decrease accidents on the guided path. The goal of a good design is to ensure that road users do not make any mistakes and eliminate the risk of drivers becoming irresponsible. However, it has been observed that safety is given far less attention in India than in wealthy countries. The following conclusions can be inferred from the foregoing suggestions and the current comprehensive Road Safety Audit of the four-lane National Highway-48:

1. Most of the minor junctions had sight distance problems due to vegetation when approaching to main highway. Informatory sign boards showing name of the access road to the main highway was also missing. Accidents were observed to be more at those locations.
2. Safety barriers were missing at high embankment area, along the curves, and near settlements. Safety barriers were not connected properly with the rigid concrete safety barriers at some locations.
3. Due to vegetation, Visibility along the curves was not proper. At curves, missing/removed curve sign boards were also found.
4. Service roads were encroached by parking vehicles and local vendors. At some locations, no provision for service road was also found.
5. Level difference in between minor junctions of approach road and National Highway-48 was observed. No traffic control was found on these minor junctions and these junctions were undeveloped.
6. It was also found that local people were damaging median kerbs of some locations of the study stretch which were using as unauthorized median openings. Improper U-Turns were found with missing solar blinkers and informatory sign boards.
7. Lacking of Informatory sign boards was also found on highway segment. Sign posts were installed but still cautionary/mandatory sign boards were found missing from the post.
8. Provision for Truck Lay Byes was not found because of this, trucks were parked along the shoulder or carriageway which was causing congestion and availability of less carriageway width for traffic movement.

6.2 Future Scope

This study is carried out on “Behror- Shahpura on National Highway-48”, these can be extended to the entire stretch of four-lane National Highways in order to carry out Road Safety Audit for the benefit of the road users. With the help of study, most influencing safety parameters for road accidents for any other four-lane National Highways can also be found out.

VII. REFERENCES

[1.] Guozhu Cheng, Rui Cheng, Yulong Pei, Juan Han, "Research on Highway Roadside Safety", *Journal of Advanced Transportation*, vol. 2021, Article ID 6622360, 19 pages, 2021. https://doi.org/10.1155/2021/6622360.

[2.] Montoya-Alcaraz, Marco, Alejandro Mungaray-Moctezuma, Julio Calderón-Ramírez, Leonel García, and Cynthia Martinez-Lazcano. 2020. "Road Safety

Analysis of High-Risk Roads: Case Study in Baja California, México" *Safety* 6, no. 4: 45. https://doi.org/10.3390/safety6040045.

[3.] Won-Joon Wang, Soojun Kim, Kyung Tak Kim, ChoongKe Lee, Hung Soo Kim, "Analysis of Applicability of Grid-based Spatial Analysis Data for Flood Risk Assessment", Journal of the Korean Society of Hazard Mitigation , Volume 20, pp 399-406,
2020, https://doi.org/10.9798/kosham.2020.20.6.399

[4.] Shantajit, T., Kumar, C. R., & Zahiruddin, Q. S. (2018). Road Traffic Accidents In India: An Overview. International Journal of Clinical and Biomedical Research, 4(4), 36–38. https://doi.org/10.31878/ijcbr.2018.44.08

[5.] Shalini Kanuganti, Ruchika Agarwala, Bhupali Dutta, Pooja N. Bhanegaonkar, Ajit Pratap Singh, A.K. Sarkar, "Road safety analysis using multi criteria approach: A case study in India", Transportation Research Procedia,Volume 25, 2017,Pages 4649-4661,ISSN 2352-1465,https://doi.org/10.1016/j.trpro.2017.05.299.

[6.] Hitesh kumar and Mrs. Monika, "Research Paper on the Road Safety Audit and a Case Study on Kaithal-Kurukshetra Road Haryana, India", International Journal of All Research Education and Scientific Methods (IJARESM) ISSN: 2455-6211, Volume 5, Issue 5, May- 2017.

[7.] Satyam,P.,andMogre,S.K.,2017.ASpatialApproachfor Performing RoadSafety Audit ofHighways.InternationalJournalofAdvancedEngineeringTechnology,vol.3, no.9, pp.504-510.

[8.] Maru D. Freny (2016), "Identification of Black Spot on SH-24- A Case Study of Madhapar Chowk to Hadala". International Journal of Futuristic Trends in Engineering and Technology, Volume III, Issue V, April 2016.

[9.] Singh,S.K.,2016.RoadtrafficaccidentsinIndia:issuesandchallenges.Transportation researchprocedia,vol.25, pp.4708-4719.

[10.] Mohan,D.,Tiwari,G.andMukherjee,S.,2016.Urbantraffic safetyassessment:acase studyofsixIndiancities. IATSSresearch,39(2), pp.95-101.

[11.] Krunal Patel, et-al. 2015, "Review on Road Safety Aspect in Transportation", Indian Journal of Applied Research, Volume : 5 | Issue : 4 | April 2015 | ISSN - 2249-555X.

[12.] Jain, A.M. and Vaidehi, P. (2014), "Road Safety Audit-An Identification of Black Spots on Busy Corridor Between Narnol-Naroda of Ahmedabad City", International Journal of Engineering and Technical Research, ISSN: 2321-0869, Volume-2, Issue-3, March-2014.

[13.] Michalski L. and Gaca S. (2014) "Tools for road infrastructure safety management- Polish experiences"17th Meeting of the EURO working group on Transportation EWGT2014, 2-4 July 2014, Sevilla, Spain.

[14.] Agarwal, P. K. and Mehar, R. (2013) "A Methodology for Ranking Safety Hazardous Locations Using Analytical Hierarchy Process" 2nd Conference of Transportation Research Group of India (2nd CTRG), Procedia-Social and Behavioral Sciences 104 (2013) 1030-1037.

[15.] Development of Toolkit under "Sustainable Urban Transport Project", Urban Road Safety Audit, Ministry of Urban Development Government of India, December 2013.

[16.] Hongbo, Xu and Dongxiao Z., "The Practice of Road Safety Audit on Expressway in China", 16th Road Safety on four Continents Conference, 15-17 May 2013, Beijing, China.

[17.] Ravinder, K and Nataraju, J, "Road Safety Audit of National Highways in India at Construction Stage", CSIR, 13th WCTR, July 15-18, 2013-Rio de janeiro, Brazil.

[18.] Jain S.S., Singh P.K. and Parida M. (2011), "Road Safety Audit for Four Lane National Highways", 3rd International Conference on Road Safety and Simulation, September 14-16, 2011, Indianapolis, USA.