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# Road Safety Audit of existing road: A Study for Yedeshi-Aurangabad BOT (NH-52)

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**ABSTRACT:** India has second largest population within the world. India is developing country and having world's largest heavy traffic and accidents also. it's necessary to supply the security to roads. Road Safety Audit (RSA) may be a procedure or method within which identification of existing or future road on basis of issues of safety and provision of safety remedial measures on that. In this study, the section of road from :Four Laning of Yedeshi to Aurangabad section of NH-211 (new NH No-52) from Km.100.000 to Km.290.200 within the State of Maharashtra To be executed as BOT (TOLL) on DBFOT pattern under NHDP Phase- IV-B on EPC Mode" is undertaken. This study is considering traffic during day time, evening time and mainly black spots on the road where accidents takes place continuously. The parameters vital for safety are selected and quantified using two multi-criteria deciding analysis tools: Simple Additive Weightage (SAW), Analytical Hierarchy Process (AHP) results are compared. The methodology presented herein gives an insight to prioritize roads for safety mitigation measures which is predicted to be useful to varied decision makers.

**KEYWORDS:** Road safety, Accident, Four laning of NationalHighway.

## I. INTRODUCTION

Road fatality rates in India are probably among the very best and out of 1.25 million deaths worldwide per annum, 8-10 per cent of all road deaths are in India. The road system and therefore the traffic operations in India are deficient in safety management. one in every of the explanations for this case is that there's little opportunity to be told from the past mistakes. The accident records are imagined to provide the clue about deficiency within the road, vehicle and user systems to elucidate the causes of accidents and to develop remedial measures. This road safety management system is poor in India, with untrained cops collecting only incomplete records of fatal accidents and always stating the road user's fault because the reason behind the accident. in a very road environment where the road designs, knowledge of traffic rules, control and policing (enforcement) are accountable for the accident. in an exceedingly deficient road and traffic environment, causes are associated with poor road geometry and poor control aggravated by poor traffic sense. The National Highways Authority of India (NHAI) is engaged in development of National Highways entrusted thereto by MoRT&H. As a part of this endeavor, the Authority has obsessed development of a number of the highways through EPC mode, it's stipulated within the EPC Agreement that the Contractor shall appoint a security Consultant to hold out safety audit at the planning, Construction & Completion Stage of the project highway in accordance with the Applicable laws and Good Industry Practice. The Project Corridor i.e. " Four Laning of Yedeshi to Aurangabad section of NH-211 (new NH No-52) from Km.100.000 to Km.290.200 within the State of Maharashtra To be executed as BOT (TOLL) on DBFOT pattern under NHDP Phase- IV-B on EPC Mode" is one such corridor identified by the Authority. "M/s YEDESHI AURANGABAD TOLLWAY PRIVATE LIMITED" has been selected as preferred bidder by Authority for the Project & called as "EPC Contractor".

## OBJECTIVE OF THE PROJECT:-

The primary goal of RSA is to reduce the likelihood of crashes on current roads and future road projects, as well as the severity of any crashes that do occur or are likely to occur.

There are additional goals as well, such as:

- Reducing the risk of collisions on nearby roadways (especially at intersections).
- To know the value of road safety.
- Designing to meet the requirements and perceptions of all road users, as well as achieving a balance between competing needs.
- To lower the long-term expenses of a new road project, keeping in mind that correcting risky designs may be costly at a later stage.
- To raise public awareness about the importance of road safety



- Adherence to engineering principles by all parties engaged in the planning, design, building, operation, management, and maintenance of roads and highways.
- Raise awareness of the importance of providing safe and schemes for both non-motorized and motorized road users.
- To find most critical section of road by using two multi-criteria decision making analysis tools.

## II. RELATED WORK

### **Identifying Critical Safety Issues on Two-Lane National Highways in India –A case study from NH 117 and NH 60. (Sudipa Chatterjee , Partha Sarathi Bandyopadhyaya, Sudeshna Mitra ), 2019**

In this case study authors has analyses the sections of NH-60 from Morgram to Kharagpur and NH-117 From Bakkhali to Joka which is under the Ministry of Road Transport and Highways. Authors aims to identify the critical safety issues observed during RSA on the two major two lane undivided highway in the state of west Bengal. Several risk factors were identified at different hazardous locations along the highway stretches during the RSA lack of infrastructure intersections of vulnerable road uses (VRU) with high speed traffic and faulty geometric design are some of most alarming safety deficiencies identified through the audit process.

### **Road Safety Audit as a Tool for Improving Safety on the Intercity Road Network (Kristina Baklanovaa,\*, Evgeny Voevodina, Elena Chebana, Andrey Askhabova, Artem Kashuraa ) 2020**

The article describes the purpose and essence of road safety audit. For a more detailed review on the road safety audit procedure on highways, a federal road of the Krasnoyarsk region was chose. After analysis of official statistics and accident reports several priority sections requiring some special attention were identified. Using the road safety audit methodology, an accident analysis was carried out and emergency-dangerous sections of the Federal highway R-255 were identified. The method was used to determine the road sections with a high rate of accidents. The road safety audit allows us to analyze the factors of road conditions and the road schemes and simulate real accidents using the PC-Crash program for reconstruction of road accidents. Based on these data, it is possible to take the best measures to eliminate the road sections with a high rate of accidents. Evaluation of the effectiveness of measures is carried out with repeated modeling in the PC-Crash program.

### **Road safety analysis using multi criteria approach: A case study in India.(Shalini Kanugantia, Ruchika Agarwalab, Bhupali Duttac,) 2016**

In this paper a study was carried out to determine the priority of safety requirements of a certain category of rural roads, viz., Pradhan Mantri Gram Sadak Yojana (PMGSY) roads in the Jhunjhunu district of Rajasthan, India. The parameters vital for safety have been selected and quantified using three multi-criteria decision making analysis tools: Simple Additive Weightage (SAW), Analytical Hierarchy Process (AHP) and Fuzzy AHP methods and results are compared. The methodology presented herein gives an insight to prioritize roads for safety mitigation measures which is expected to be useful to various decision makers.

### **Systemic approach to auditing road traffic accident black spots.(Elena Kurakina, Pavel Kravchenko, Ilya Brylev , Jaroslaw Rajczyk) 2020**

In this paper authors are described a conceptual model of the systemic approach to auditing road traffic accident black spots is developed. This model includes interrelations of subsystems, factors of accident-prone situations, causes of the emergence of road traffic accident black spots in the system “road user – vehicle – road – external environment” (RUVREE). This model justify the qualitative assessment of Road Traffic Safety , Road traffic accidents (RTAs) & Road Traffic Accident Blackspots(RTA Bss).

### **Safety performance audit for roadside and median barriers using freeway crash records: Case study in Jiangxi, China. (Y.G. Wang, K.M. Chena, Y.S. Ci , L.W. Hu) 2011**

In this case study authors has analyses the safety of the existing, as-built, local road facilities and it include the three existing, typical freeways in Jiangxi, China, for the study of routine road safety audit process, a total of 172 roadside crashes are collected. Based on studies Several critical issues were identified and improvement suggestions were recommended i.e roadside Clear Recovery Zone (CRZ), weak barrier structures, unprotected roadside obstacles (i.e. barrier ends, advertisement signs, drainage ditches, etc.), and poor connections or transitions of rails.

## III. METHODOLOGY

Every work has a specified methodology. Safety Audit can be taken on new roads, existing or constructed roads. The findings from the Safety Audit after constructed stage carried out for in this study, the section of road from: Four



Laning of Yedeshi to Aurangabad section of NH-211 (new NH No.52) from Km.100.000 to Km.290.200 in the State of Maharashtra to be executed as BOT (TOLL) on DBFOT pattern under NHDP Phase- IV-B on EPC Mode.

- The Audit comments on each of the road safety issues with safety recommendations to minimize the problems.
- Checklist is useful to assist the audit team. These checklists describe the performance and situations that can affect the road safety of selected types of projects and audit stage.
- Road Safety Audit Checklists are presented in **IRC:SP:88-2019,"MANUAL ON ROAD SAFETY AUDIT"**
- The checklists are for use during an audit when;
  - Assessing the documentation; in particular, when the project drawings are being examined.
  - Inspecting the site. At this point, it is important to visualize how the project will fit into the existing features.
  - Writing the audit report – to re-check that the relevant issues have been addressed.
- This checklist can be used on existing roads, new roads, roadwork traffic schemes, rehabilitation works, etc.
- Summarised data with all the attributes from the checklist.
- Divide all project length in different section to find most critical section of the road.
- Select the most effective attributes responsible for road safety.
- Analyse the data from different multi-criteria decision making tools i.e. (SAW Method & AHP Method).
- Find the most critical section of the road.

#### IV. DATACOLLECTION & OBSERVATIONS

Total road project length is divided in to four section for finding most critical section of the road.

- 1) **Section 01 from Ch: 100+000 TO 149+000**
- 2) **Section 02 from Ch: 149+000 TO 197+000**
- 3) **Section 03 from Ch: 197+000 TO 243+000**
- 4) **Section 04 from Ch: 243+000 TO 290+200**

#### The following concerns are observed during site inspection:

- 1) Pot holes/ Patch Works are present at many locations and not maintain/ repair accordingly.
- 2) Rutting is observed at various locations.
- 3) Blinkers, hazardous markers are absent/ damages at various junctions and near the structures.
- 4) Guard rail and MCB are damages at many locations and obstructing the road traffic movement.
- 5) Shoulder erosion is observed at most of stretches.
- 6) Delineators are not available as per required frequency at curve portion of the road.
- 7) Unauthorized openings are observed at many locations.
- 8) Ambulance present in site is not as per IRC: SP: 84 specifications.
- 9) Road side and median drain is not clean.
- 10) Hygiene is not maintained at public toilet and primary health tool kit also absent.
- 11) Road marking is dull and damages at many locations.

Attributes	Section 01	Section 02	Section 03	Section 04	Total
<b>Unauthorized Opening</b>	105+630, 113+360, 115+897, 127+890, 129+720, 132+098, 137+411, 141+830, 143+890, 144+055, 147+092.	156+039, 162+087, 172+047, 193+062	204+001, 208+330, 210+210, 212+820, 219+243, 220+302, 231+009, 239+700, 240+050.	245+432, 251+099, 258+127, 260+023, 267+788, 272+200, 288+093.	Section 01 = 8 Section 02 = 4 Section 03 = 9 Section 04 = 7 <b>Total = 28</b>
<b>Pot holes/rutting locations</b>	105+850, 113+786, 115+940, 132+235, 138+045, 143+493, 147+891.	154+711, 159+987, 175+680, 178+907, 181+654, 188+154.	208+870, 212+543, 221+905, 226+541 .	249+721, 253+061, 263+984, 265+046, 268+094, 274+182, 276+053, 278+072, 281+011, 285+690, 286+088. 287+109.	Section 01 = 7 Section 02 = 6 Section 03 = 4 Section 04 = 12 <b>Total = 29</b>
<b>Blinkers/hazardous absent at junction</b>	101+490, 103+490, 113+545, 117+315, 121+200, 121+641, 124+820, 127+840, 130+825, 132+220, 134+108, 137+700, 139+609, 141+110, 143+885, 146+130, 147+140.	149+225, 151+098, 153+051, 155+251, 157+913, 159+535, 161+321, 163+047, 165+277, 173+425, 174+643, 176+500, 177+860, 178+910, 181+772, 184+350, 187+100, 189+600, 189+620, 193+517, 195+683.	197+639, 199+432, 199+480, 201+367, 203+330, 204+410, 205+100, 205+798, 210+200, 212+481, 213+700, 214+261, 214+320, 215+460, 216+695, 217+636, 219+720, 223+820, 225+375, 226+464, 228+462, 232+378, 233+071, 236+765, 238+300, 240+023, 240+843, 241+460	243+210, 244+210, 246+120, 247+435, 248+120, 258+264, 261+860, 262+772, 265+130, 267+807, 271+510, 273+520, 274+100, 275+180, 276+130, 184+956, 286+890, 287+400, 288+892	Section 01 = 17 Section 02 = 23 Section 03 = 29 Section 04 = 19 <b>Total = 88</b>
<b>Guard rails and MBCB damage</b>	106+403, 109+709, 113+654, 136+563, 142+056, 147+050	154+067, 160+365, 162+078, 168+098, 173+677, 178+420, 179+032, 181+043, 187+056, 192+058, 196+675.	198+850, 199+389, 205+870, 215+327, 218+654, 220+765, 228+908, 232+054, 241+213.	245+830, 249+987, 249+436, 253+644, 261+666, 263+787, 265+890, 271+876, 276+765, 278+432, 281+899, 283+654, 285+653, 287+867.	Section 01 = 6 Section 02 = 11 Section 03 = 9 Section 04 = 14 <b>Total = 40</b>

Table : Details of data collected from different section with different attributes.



Photographs collected from site location.



VI. FINDING MOST CRITICAL SECTION OF THE ROAD

1) Simple Additive Weighted (SAW) Method :-

SAW is a simple conventional weighted average method used to calculate final scores. To calculate score corresponding to particular criteria.

$$P_i = W_i \times R_i$$

The total weighted score for a particular alternative is determined using equation (1). The results obtained from SAW analysis are shown in table.

$$LOS_i = \sum_{i=1}^n p_i / \sum_{i=1}^n w_i \tag{1}$$

Where, n = No.of attributes that define the overall safety

Pi = Individual score of each alternative

Wi = Weight associated with the ith service attribute

Ri = Value score for the ith service attribute

LOSi = Level of safety for alternatives

Table shows Ranking of alternatives using SAW method

Attributes/ alternatives	Unauthorized Opening	Pot holes/ rutting Locations	Blinkers/ hazardous absent at junctions / structures	Guard rails and MBCB damage	Final score	Rank
<b>Section 01</b>	8	7	17	6	<b>0.9017</b>	<b>2</b>
<b>Section 02</b>	4	6	23	11	<b>0.7478</b>	<b>3</b>
<b>Section 03</b>	9	4	29	9	<b>0.7440</b>	<b>4</b>
<b>Section 04</b>	7	12	19	14	<b>1.0760</b>	<b>1</b>

2) Analytic hierarchy process (AHP) Method :-

The Analytic Hierarchy Process (AHP) is a method for organizing and analyzing complex decisions, using math and psychology. It was developed by Thomas L. Saaty in the 1970s and has been refined since then. It contains three parts: the ultimate goal or problem you're trying to solve, all of the possible solutions, called alternatives, and the criteria you will judge the alternatives on. AHP provides a rational framework for a needed decision by quantifying its criteria and alternative options, and for relating those elements to the overall goal.

Stakeholders compare the importance of criteria, two at a time, through pair-wise comparisons. Example, do you care about job benefits or having a short commute more, and by how much more? AHP converts these evaluations into numbers, which can be compared to all of the possible criteria. This quantifying capability distinguishes the AHP from other decision making techniques.

In the final step of the process, numerical priorities are calculated for each of the alternative options. These numbers represent the most desired solutions, based on all users' values.

The AHP is most useful when finding decisions to complex problems with high stakes. It stands out from other decision-making techniques as it quantifies criteria and options that traditionally are difficult to measure with hard numbers. Rather than prescribing a "correct" decision, AHP helps decision makers find one that best suits their values and their understanding of the problem.



Table– Scale used for AHP calculations.

Intensity of importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity I has one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	
1.1-1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

Table shows Ranking of alternatives using AHP method:

Attributes/ alternatives	Unauthorized Opening	Pot holes/ rutting Locations	Blinkers/ hazardous absent at junctions / structures	Guard rails and MBCB damage	Final score	Rank
<b>Section 01</b>	8	7	17	6	<b>0.58790</b>	<b>4</b>
<b>Section 02</b>	4	6	23	11	<b>0.63106</b>	<b>3</b>
<b>Section 03</b>	9	4	29	9	<b>0.64719</b>	<b>2</b>
<b>Section 04</b>	7	12	19	14	<b>0.86286</b>	<b>1</b>

VII. COMPARISON OF RESULTS

Alternative	Simple Additive Weighted Method (SAW)	Analytic Hierarchy Process (AHP)
<b>Section 01</b>	2	4
<b>Section 02</b>	3	3
<b>Section 03</b>	4	2
<b>Section 04</b>	1	1

As per Multi decision criteria analysis the parameter which governs safety considered as unauthorized openings, Pot holes/rutting locations, Blinker/hazardous absent at junctions/ structures, Guard rails and MBCB damage.



According to SAW and AHP methods, section 04 is the most critical section, whereas section 03 & section 01 is in the best condition respectively. As per SAW analysis, section 01 seems to be the second most critical section, while according to AHP analysis, section 03 is now the second most critical section.

### VIII. CONCLUSION

Present study gives on insight of how the analysis of road safety audit to the different sections of the road can be done from the multi-criteria decision making tools. The methodology presented herein given an insight to prioritize road for safety mitigation measures which is expected to be useful to various decision makers. Analysis of the road safety shows road section 04 to be most critical section and section 01 & section 03 are to be found best a safety point of view as obtained from two methods. These results are very helpful for selecting most critical road section on priority basis to ensure the road maintenance budget are distributed wisely.

Variation in results for ranking of road section-01, section-02, and section-03 has been observed but it is not too much significance as the two methods show the same road to be in the most vulnerable state. The methodology suggested can be used to determine the level of contribution of parameter towards safety hazards.

### IX. FUTURE SCOPE

This work can be implemented in not only National highways but in other roads too i.e. state highways, district roads etc. After implementation of this work, it will definitely useful for finding the most critical section of road which is very beneficial for distribution of budget wisely. A further detailed study needs to be conducted on a large scale by carrying out sensitivity analysis to test the stability of the ranking obtained by the different multi-criteria decision making methods.

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