Measuring the Level of Road Safety through Road Safety Audit– A Case Study from Himalayan Expressway

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Abstract
National Highways (NH) carry the major portion of the total traffic in India. Road safety on NH is therefore of paramount importance. In the present study, a road safety audit has been performed for a 4-lane NH using Star Rating method. VIDA software developed by International Road Assessment Programme (IRAP) is used for finding the Star Rating of the road sections. This safety rating has been determined for four road user types: Vehicle occupant, Motorcyclist, Pedestrian and Bicyclist. The purpose of the study is to measure the level of road safety and lower the severity level by proposing countermeasures. The case study is a 5(km) section of NH-5 from Sanwara toll plaza to Jabali in the state of Himachal Pradesh in India. Encroachment on the land, roadside activities, insufficient infrastructure, imperfections in the geometric design, and non-motorized access were some of the severe safety flaws identified through the study process. The Star Rating results indicated that among all the road user types, the vehicle occupant is much safer than the others.

1. Introduction
Road safety not only saves lives but also boosts the country's economy. As India is a developing country, many roads have been built or in the process of being built in recent years. Road safety records of past years also indicates that there is a need for more safety improvement programs, which is necessary from time to time [1]. According to the World Road Statistics, 2018, India tops the 199 countries in terms of road accident mortality. According to the World Health Organization's 2018 Global study on road safety, around 11% of all deaths caused by accidents occur in India. On the National Highways (NHs) of India which account for 2.03% of the entire road network, a disproportionate share of 35.7 percent of road accident deaths occurred in 2019. Among various types of vehicles, two-wheelers account for 35% of all road accident deaths on NHs, followed by Light Motor Vehicles (18.6%), pedestrians (14%), trucks (10.7%), buses (4.9%), and bicycles (2.9%). In 2018, India's total estimated socio-economic cost of road accidents was Rs. 1,47,114 crores, equal to about 0.77 percent of the country's GDP. Typically, four variables cause road accidents: driver/rider behaviour, vehicle issues, road factors, and environmental factors. One of these, the road factors may be significantly improved by applying engineering principles. The present study demonstrates how road factors can influence the road safety and why their accurate measurement can significantly improve the overall safety on NHs. The RSA is first carried out to identify the road features that can cause road accidents. This is followed by rating the highway sections based on their safety features for occupants of automobiles, motorbikes,
pedestrians and bicyclists. Based on the findings of RSA and the safety rating, suggestions are proposed to fill the gaps and improve the overall safety for all types of road user.

2. Study method
The task of identifying the section's deficiencies by performing a road safety audit and implementing a star rating system to assess the present level of safety provided to road users. Finally, measures for improving the rating and reducing the deficiency have been discussed. The existing 5-km segment accommodate significant volume of traffic and the deficiency on it was almost similar across the National Highway 05. This segment was chosen in view of the fact that major accidents occurred over the section as compared to the overall length of NH 05. A survey of the road section was conducted through visual inspection as well as videography. Various road attributes and traffic characteristics were collected in the process.

![Diagram](image)

**Figure 1.** Road safety audit and star rating plan process

- **Road attributes and data collection**

**Road safety audit**
The locations of accident sites were also obtained from the National Highway Authority of India (NHAI) office. The process of RSA as outlined in the manual on road safety audit called IRC SP 88–2019 is an exercise to improve road safety and reduce accidents by involving checks on various stages of highway development such as planning, designing, construction, at handover, and during operation [5,17]. The present study has performed RSA on an operational 4-lane highway. The survey consisted of obtaining information about the following: Sight Distances, Intersections, Interchanges, Crossing Segments, Roadside Obstacles, Drainage, Signposts, Pavement Markings, and Delineation, Vulnerable Road Users, Access to Property and Advancements, Issues with Lighting and Night-time troubles, General Road Safety Considerations.

The evaluation and subsequent rating of all NHs is to be carried out twice a year in the months of October and April, before and after the rainy season. It has been observed that the road conditions in India vary to some extent after the monsoon season. The highway rating is to be done based on three broad parameters: efficiency, safety, and road users’ perspective. The present study is focused on safety.
Star rating method
Star Ratings involve an inspection of road infrastructure attributes that are known to have an impact on the likelihood of a crash and its severity. Based on some input information, the software assigns a star rating to the road. The most secured roads with a star rating of 5 have road safety features that are sufficient for the prevailing traffic speeds. Some of the road infrastructure elements on a safe road are division of opposite traffic by a broad median or barrier, good lane-marking and design of junctions, providing extra lane width, sealed (paved) shoulders, clear of vulnerable risks on the roadside such as poles, and adequate provision for bicyclists and pedestrians such as footpaths, bicycle lanes and pedestrian crossings. The software computes and displays the star rating for a road user type based on the input road attributes.

Star Rating is obtained through VIDA for each of the four road user categories that account for the majority of road users on Indian roads: vehicle occupants, motorcyclists, bicyclists, and pedestrians. The types of crashes that can occur for each type of road user is provided in Table 1.

<table>
<thead>
<tr>
<th>Vehicle occupants</th>
<th>Motorcyclists</th>
<th>Bicyclists</th>
<th>Pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Run-off road</td>
<td>• Run-off road</td>
<td>• Riding along the road</td>
<td>• Walking along the road</td>
</tr>
<tr>
<td>• Head-on</td>
<td>• Head-on</td>
<td>• Collision on intersections and</td>
<td>• During crossing the road</td>
</tr>
<tr>
<td>• Collision on intersections and access points</td>
<td>• Collision on intersections and access points</td>
<td>access points</td>
<td></td>
</tr>
<tr>
<td>• Travelling along the road</td>
<td>• Travelling along the road</td>
<td>• Run-off road</td>
<td></td>
</tr>
</tbody>
</table>

3.CASE STUDY
A 4-lane dual carriageway NH built recently has been selected as a case study. This 5-km section from Sanwara toll plaza to Jabli market is a part of 120-km Parwanoo-Solan NH which is managed by NHAI. It is currently a partial access-controlled expressway but is expected to be fully access-controlled in near future. The first phase of the project, about 28km in length from Zirakpur in the state of Punjab to Parwanoo in the state of Himachal Pradesh became functional in April 2012. The other phase of the project, about 39km in length from Parwanoo to Solan in Himachal Pradesh began operation in April 2021.

![Figure 2. Google image of 5km road length of selected Highway](image)

4.Results and discussion
RSA findings
The major audit findings are discussed along with site photographs in Table 2 and Table 3 contain a detailed list of risk elements and potential solutions or countermeasures to enhance safety. A large number of curves did not have enough sight distance due to insufficient set back distance.
Median opening. Delineators are not installed on some median openings due to which the drivers may have trouble in visibility during the night and the availability of sight distance was also less in such locations.

Shoulder condition. The shoulder condition was poor across the length, which may lead to accidents involving automobiles and the pedestrians.

Drainage. Although side drains were available, they were obstructed at many places.

Illegal vehicle parking. Illegal parking in front of the hotels and restaurants was frequent resulting in reduced road width and hindered visibility.
Dumped materials. Construction material has been dumped at many places along the highway.

Figure 8. Dumped construction material near crash barrier and on service lanes

Broken barriers. Crash barriers were damaged in several locations and installation finishes were generally poor.

Figure 9. Damaged crash barrier

Lighting issues. Populated areas lacked sufficient lighting which can put pedestrians at risk during night time.

Figure 10. Poor visibility

Star rating
Star rating was performed at three locations which were selected based on accident data and RSA findings. The road attributes such as roadside details, mid-block details, intersections details, flow details, vulnerable road users (VRU) facilities and land use, speed Details that were entered into the ViDA to generate Star Rating.

All ViDA users have access to the Demonstrator, which may be used to create Star Ratings for single locations or small portions of road. The Demonstrator is especially useful for figuring out how certain road elements affect Star Ratings. To access the Star Rating Demonstrator, first step is to select the ‘Demonstrator’ button on the ViDA Dashboard. After that, all of the road attributes were entered into the Demonstrator, and the rating is presented by clicking on the star rating tab. The Star Ratings for the specified road attributes are displayed in the Star Ratings display. The star rating result has been obtained as shown in Figure 15. This particular location has a 1-star rating for bicyclists and pedestrians, 3-star...
rating for motorcyclists, and 4-star rating for vehicle occupants. Based on the results, this particular highway is quite safe for vehicle occupants, but quite unsafe for pedestrians and bicyclists. The star rating results obtained for all the three locations is shown in Table 2. Suggestions to mitigate risks identified through RSA are given in Table 3.

![Star Rating Demonstrator](image)

**Figure 15.** Generated Star Rating for the road attributes selected

The following suggestions are proposed to improve star rating scores:
- Segregate the Bicyclists and Motorcyclists from interactions with larger, heavier vehicles and the risk for conflicts by providing separate Bicycle and Motorcycle Lane
- Shoulder should be maintained, along the entire length of the road
- Streetlights must be installed in habitat areas, median openings, sharp curves, and other spots where accidents are likely to occur
- Development of a walkway in the habitat area, as well as crossing facility at junctions
- Increasing the visibility of road markings and traffic signs

5. Conclusion
A large number of NHs have been recently constructed or upgraded in India. The owner, NHAI desires to carry out a periodic assessment of these roads for safety. Based on the parameters identified by NHAI and safety standards defined by NHAI, the present study was undertaken to identify the safety deficiencies on a four-lane NH. Along with RSA, ViDA software was used to assign safety-based star rating to the selected highway sections. The RSA findings show deficiencies such as lack of appropriate sight distance at horizontal curves, poorly illuminated median openings and built-up areas, missing pedestrian facilities, illegal parking, dumped construction material along the roadside, and damaged shoulders. The outcome of the star rating through ViDA software indicates that although the highway is safe for vehicle occupants, it is highly unsafe for bicyclists and pedestrians who are at significant risk. For motorcyclists, the highway scores average rating for safety. The following are the key outcomes from the RSA-based inspection and Star rating.
- Due to landslides debris on the road, encroachment, and overgrowth of vegetation in the median, the deficiency of appropriate sight distance was constantly noted at the curves and at the junction entrances across the study road, despite the fact that sight distance is one of the most important needs on high-speed routes like NHs.
- The lack of adequate infrastructure such as a walkway, crossover bridges, and bicycle lane had exposed bicyclist and pedestrians to high-speed vehicles.
- Road users were found to lack the fundamental understanding of road safety. This is because drivers aren't used to high-speed facilities in densely populated places. The majority of drivers were found to be driving faster than the posted speed limit.
Road users can be influenced, and their current attitudes and habits can be changed by awareness and education. Implementing course-based road safety instruction can help young people to develop safe mindsets early on, reducing the likelihood of future traffic crashes.

References


15. International Road Assessment Programme (iRAP), iRAP Methodology Fact Sheet #1, pp. 1–3, 2014.


