

Safety Assessment of a Road Transport Network

Pillai Akshara Radhakrishnan¹, Dr. K. Athiappan²

¹PG Student, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India

²Associate Professor, Dept. of Civil Engineering, Jyothi Engineering College, Kerala, India

Abstract - The roads in India have been subjected to a huge number of road accident. Road accidents have become a major reason for death. Hence, it is the need of the hour to check the factors leading to road accidents and find out mitigations or countermeasures required. iRAP (International Road Assessment Programme) thus helps in providing the star ratings protocols and methodology for rating the road network for each group of road users that is vehicle occupant, motorcyclist, pedestrian and bicyclist. The roads are rated from 1 star to 5 stars, 1 star indicated by black colour being the most dangerous road stretch and 5 stars indicated with green colour being the safest roads. Colour coding is green, yellow, orange, red and black with the safety decreasing from green to black. The aim of iRAP is to evaluate the road network around the globe and to understand the shortcomings of the roads for economically and effectively applying corrective measures to prevent fatalities and serious injuries caused due to road accidents. The iRAP has developed an online software called ViDA for the same which is easily available. This paper gives an overview of star ratings, RAP (Road Assessment Programme) around the world, two approaches of star ratings.

Key Words: Star rating, ViDA software, iRAP, Accidents, Vehicle occupant, Motorcyclist, Pedestrian, Bicyclist.

1.INTRODUCTION

Road accidents and fatalities due to road accidents are increasing day by day. This not only affects the road users but also creates a pressure on the economy of the country. Thus, International Road Assessment Programme (iRAP) has developed a method for star rating the road on a scale 1 to 5 along understanding the shortcomings and causes of road accidents and providing economic evaluation of each countermeasure in terms of Safety Road Implementation Plan. AusRAP, IndiaRAP, usRAP, My RAP, ChinaRAP, EuroRAP, kiwiRAP, SaRAP are some of the RAPs working with the iRAP in every country worldwide. This method proves to be beneficial for less developed countries where economy is a constraint as well in situations where the crash data is unavailable. The iRAP provides facilities for rating roads of all kinds and over a large stretch of road. It star rates every 100 meters of the entire road network. The black colour indicates very dangerous roads, red colour indicates dangerous roads, orange colour indicates moderately safe roads, yellow colour indicates safe roads

and green colour indicate very safe roads. 1 star is indicated by black colour, 2 stars is indicated by red colour, 3 stars is indicated by orange colour, 4 stars is indicated by yellow colour and 5 stars is indicated by green colour. It should also be noted that as the speed of the vehicles increases the star rating scores increases and star ratings decreases. Also, the star ratings for two identical roads in terms of geometry and road features will have different star ratings if the speed of the road users in both the roads are different. It is not possible or smart way to reconstruct the entire road in case of high number of accidents, thus star rating helps understanding and finding out the sections that are lacking in terms of safety and provide countermeasures where required. It helps in economically applying the countermeasures. This will help in serving countries where economy is a constraint along with other countries to save up some money.

2.ROAD ASSESSMENT PROGRAMME (RAP)

Road Assessment Programme (RAP) analyses road networks around the world. The main motive is to treat the infrastructure for making the roads safe. Treating the roads will ultimately help in reducing and preventing fatalities and serious injuries caused due to road accidents. RAP also conducts workshops and training programs along with providing tools for rating. RAP is now lively operating in more than 80 countries. The countries include India, Australia, New Zealand, China, USA, Brazil, South Africa, Malaysia and many more. The objective of RAP is forming a relationship between countries focusing on the same aim, to reduce or prevent deaths and serious injuries due to road accidents, to evaluate safety of road stretches, to develop effective and efficient decisions related to road safety. The protocols include risk mapping, safety scores and performance tracking.

2.1 International Road Assessment Programme (iRAP)

The iRAP or International Road Assessment Programme is an organization that runs by charity to make roads safer for all road users. It was founded in the year 2006 and is the organization that comes under RAP or in other words iRAP comes directly in contact with RAP. Under iRAP comes all the RAPs from various countries. FIA Foundation for the Automobile and Society, National government, Association of automobiles, World Bank and RSF (Road Safety Funds) are some of the organizations

that is providing a financial backup to iRAP. The main aim of the iRAP is make all the roads green (5 star rated).

IndiaRAP is one of the RAP that comes under iRAP. This was formed because the around 1,51,417 fatalities due to road crashes were observed along with this the GDP of the country by 3% every year followed by personal financial loss. iRAP and AITD (Asian Institute of Transport Development) joined together to form IndiaRAP and RAP for India was finally launched in the year 2017. iRAP is backed up by IRC (Indian Road Congress), MoRTH (Ministry of Road Transport and Highways), IIT, CRRI (Central Road Research Institute), National Highway Authority of India (NHAI), IAHE (Indian Academy of Highway Engineers), GRSF (World Bank Global Road Safety Facility) along with several help for the state level. iRAP has evaluated around 12,000 km of road stretches along with 12 projects being conducted in Andhra Pradesh, Kerala, Assam, Punjab, Gujarat, Telangana, Karnataka, Uttar Pradesh, Haryana. The main project done under IndiaRAP is assessing the Golden Quadrilateral which is 5000 kms in Mumbai, Chennai, Delhi, Bangalore. IndiaRAP assessed SH-20 in Karnataka and after star rating and provision of the countermeasures recommended by the software the star rating improved and the fatalities reduced by 50%. Around 3000 kms of road networks in India are currently being upgraded according to the countermeasures recommended.

EuroRAP is the RAP for European countries. The main aim is to develop a Europe with safe roads. They also focus on reducing road accidents by 50% and to make 75% of the road 3 star or better. EuroRAP currently focuses on developing rural road throughout the European countries. The inter-urban roads are responsible for 30% of fatalities which is has been prioritized by the EuroRAP for star rating programme. The crashes have to be reduced on the TEN-T (Trans European Transport Network). The objectives are to reduce fatalities and serious injuries on the roads across Europe by testing and understanding the factors responsible for crashes and shortcomings thus to provide apt countermeasures. The protocols include to colour code the roads based on its risk for every road user, then identify the number of road users being killed and seriously injured and finally by checking the changes brought in by the countermeasures and see how well the road users are protected.

AusRAP is the RAP for Australia and is a formed with the help of AAA (Australian Automobile Association). AusRAP aims in significantly reducing road crashes and bringing up the safety standards of Australian roads. AusRAP has examined around 21921 kms of the road network around the country with the speed limit of 90 kmph and above. The Queensland's Bruce highway in Australia which is in the Cooroy to Curra section had a history of large numbers of fatalities and serious injuries

occurring due to road accidents. AusRAP conducted star rating the same stretch and after star rating countermeasures were provided. One of which was to provide a bypass between the start and end point of the section and it was found that the star rating increased along with providing safety to the road users. The speed limit previously was 90 kmph however after improvements the speed limit was 110 kmph. Even after the increased speed the accident rates was halved.

UsRAP is the RAP for The United States of America or USA. usRAP was launched after the success of EuroRAP and AusRAP. By the year 2018 usRAP started providing online classes and training programs for making people aware about the star ratings and increasing its popularity among various countries. The usRAP aims in providing easily understanding tools for star ratings and developing safer roads to road users, road developers, road investors and other organizations. By the implementation of the countermeasures the socioeconomic costs were seen reducing to half. UsRAP uses videos and other data for star rating the road network on a scale from 1 to 5 and providing appropriate countermeasures.

KiwiRAP is the RAP for New Zealand which comes under iRAP. KiwiRAP is backed up by ANCAP (Australian New Car Assessment). This generates star ratings for each vehicle type based on the safety they offer to the users. The main aim is to reduce death and serious injuries on the roads in New Zealand by understanding the drawbacks and shortcomings of the road and providing required engineering treatments. It also aims in offering a logical information about the risk level in the road stretch and understand the factors leading to accidents and factors that would influence the road user's behaviour. Some other RAPs are ChinaRAP which is the RAP for China, BrazilRAP which is the RAP for Brazil, SARAP which is RAP for South Africa, ThaiRAP which is the RAP for Thailand, MyRAP which is the RAP for Malaysia.

3. STAR RATING

Star ratings are provided on the basis of road features presence and traffic features like vehicle flow and speed characteristics. More than 50 road attributes are to noted for obtaining the star ratings. Star ratings are developed for each road users that is vehicle occupant, motorcyclist, pedestrian and bicyclist.

3.1 Star rating using demonstrator



Fig - 1: Star rating using demonstrator

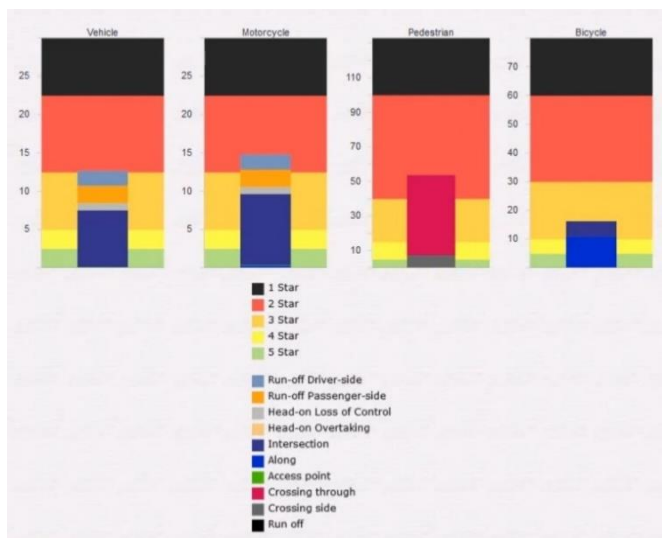


Chart - 1: Star rating in chart using demonstrator

Star rating using demonstrator is done when the length of the road stretch is 100 meters or below. The first step is to login into the software. If you are new to the site a user id and password has to be created. Then all the road attributes must be filled into the demonstrator. As the attributes are being listed onto the demonstrator the star ratings will be simultaneously developed at the top of the screen. After the final attribute has been saved the final star ratings in the form of charts for each and every road user will be shown as in the Fig 1 and Chart 1. Star ratings along with their star ratings scores and changes of collision with their type is also shown by the demonstrator.

3.2 Star rating using star rating for design

Star rating using star ratings for design is done when the road stretch is more than 100 meters. One way is to upload a photo of the road stretch and the ViDA software will itself analyse the image and note all the road features and will provide the star ratings. Another method is by creating an excel sheet of all the road attributes. The attributes are represented by a set of codes. This is done using the iRAP coding manual which is easily available on iRAP's site. A dataset has to be created from the sandbox that is present in the dashboard of the software and the sheet is to uploaded into the created dataset.



Fig - 2: Star rating in map form

Table - 1: Star rating in table form

	Vehicle Occupant		Motorcyclist		Pedestrian		Bicyclist	
	Length (km)	Length (%)	Length (km)	Length (%)	Length (km)	Length (%)	Length (km)	Length (%)
5 stars	40	1	0	0	1	0	0	0
4 stars	245	5	9	0	10	0	0	0
3 stars	2981	55	1174	22	33	1	14	0
2 stars	1881	35	3010	55	185	3	562	10
1 star	229	4	1184	22	3401	63	3363	62
NA	55	1	55	1	1801	33	1492	27
Total	5431	100	5431	100	5431	100	5431	100

Finally, star ratings will be generated. Star ratings are generated in the form of map as shown in Fig 2, table form as shown in table 1 and in chart form as shown in chart 1. The star ratings are shown in raw and smoothed form. Raw star ratings are ratings for each 100 meters. While smoothed star ratings are ratings that has been averaged over a larger span that is 1 km of the stretch for producing more meaningful results.

3.3 Safer Road Investment Plan

Safer Road Investment Plan or SRIP is a plan that is provided by the software. It gives approximately 70 countermeasures. The countermeasures are presented along with their cost of installation and the benefit that is to be acquired by its application. The number of fatalities and serious injuries reduced by the application is also shown. This makes easy for the road investors and planner for selecting the countermeasures for mitigation works. The cost shown is in millions or 10 lakhs and the life efficiency is for 20 years. Basically, when all the road attributes are analyzed by the software, the points that is sections which lacks any features that leads to accidents triggers the software and the software recommends effective countermeasure at that point or section of the road. Similarly, it is done for every 100 meters sections through the road network. All the countermeasures are applied and checked various time for its efficiency before it is been suggested, hence all the countermeasures provided will reduce or prevent accidents. The input is road attributes and traffic attributes and the output is a safety

improvement plan. The final results are shown similarly like the star rating that is in table, map and excel sheet format. The Fatalities and Serious Injuries (FSI) saved and the BCR that is the benefits obtained are the top priority of SRIP which forms a base for getting the countermeasures.

Along with this the software will also provide details in about the changes that the countermeasures will bring in terms of star ratings. Hence comparison between star ratings before and after implementation can be done to understand the efficiency and effectiveness of the countermeasures.

Safer highways through accident prevention and accident severity reduction, reduces the whole life costs of road schemes. Enhancement of road safety engineering in an economical way, Continuous monitoring and providing good quality products help in reducing future remedial work are some of the benefits of the programme. While Temporary changes in the traffic condition will alter the star ratings, resource intensive, requires strong training programs and regular quality control check making the process complex are some of the drawbacks. Another drawback is that since the attributes are in ranges, changes in the attributes if small or within the range the star ratings remain unchanged.

4. SUMMARY

The paper gives an overview about the star rating technique which is new in the transportation field. Lack of awareness about star rating in many countries and among road investors and planners are observed. Road attributes, road users flow and speed are the factors altering the star ratings. The star rating is generated for every 100 meters stretch of the roadway with 5 stars rated roads being the safest roads and 1 star rated roads being the most dangerous road sections which will also be costly for mitigation works. It has been noted that the SRIP can prevent 10,000 accidents over a span of 20 years. The countermeasures provided comes with cost benefit ratios. All the BCR were more than 1 indicating 100 percent benefits to the investors not only in terms of money but also in terms of safety. The main advantage of the star rating can be noted that along with vehicle occupant and motorcyclist it also gives priority to bicyclist and pedestrian. It is common scenario where the accident data is unavailable, difficult to obtain, or incomplete, star rating proves to be a boon in such situations because it can rate the road without accident data. The most important step currently to be applied is to develop and create awareness and teach them about star ratings and its importance among road users, road investors and road developers. Since it is not common in all the countries there must be programs and classes undertaken to make that country's road developers aware about star ratings. The RAP conducts such classes where it trains and teaches people about the star ratings. Star rating is essential so depending upon the budget available the roads can be treated. Rating

helps in systematic audit of roads, understanding shortcomings of the roads and understanding the effectiveness of newly constructed roads by providing a scalar quantity which is easy for computation and understanding. Overall, the paper gives an outline about the RAP, star ratings with an aim of increasing awareness among people about star ratings.

REFERENCES

- [1] A. Tripodi, E. Mazzia, F. Reina, S. Borroni, M. Fagnano, P. Tiberi, "A simplified methodology for road safety risk assessment based on automated video image analysis". *Transportation Research Procedia*, 275-284, 2020.
- [2] Hu, H. Smith, G. Zhang, Tiejun, "A case study of using iRAP model to improve non-motorised transport in Tianjin, China". *Road safety on 5 continents (RSSC): 17th International conference*, 2016.
- [3] L. Rogers, "iRAP star rating and investment plan implementation support guide". 2017.
- [4] N. Vashisth, "Roadway safety assessment and test application of iRAP along national highway 3 in Haiti". 2016.
- [5] S. Aziz, P. Kumar Sarkar, J. Bhavsar, "Rating and Prioritization of crashes black spots and road safety measures". *Recent advances in traffic engineering*, 579-597, 2020.
- [6] <https://s3-eu-west-1.amazonaws.com>
- [7] <https://indiarap.org/road-safety-projects/>
- [8] <https://www.kiwi.org.nz>
- [9] <https://www.roadsafe.com>
- [10] https://en.m.wikipedia.org/wiki/International_Road_Assessment_Programme
- [11] <https://www.nrspp.org.au>
- [12] <https://www.ausrap.aaa.asn.au>
- [13] <https://www.irap.org>
- [14] <https://www.ec.europa.eu>
- [15] <https://unece.org>