



3rd International Conference on Advances in Civil and Environmental Engineering (ICACEE-2024)

University of Engineering & Technology Taxila, Pakistan

Conference dates: 21st and 22nd February 2024; ISBN: 978-969-23675-2-3

The Star Rating of an Urban Arterial Road using IRAP methodology

Abid Nazir^{1, *}, Anam Ramzan¹, Muhammad Bilal Khurshid²

¹Civil Engineering Department, QCET, Sahiwal, Pakistan

² Director Transportation & Consultancy, Headquarters FrontierWorks Organization (FWO), Rawalpindi, Pakistan

*Corresponding author: abidnazirnust@gmail.com

ABSTRACT

The study introduces the International Road Assessment Program (iRAP) methodology, a five-star rating system developed in Pakistan to assess road attributes and improve safety levels, thereby reducing fatal traffic accidents. To develop a safer road investment plan, the iRAP methodology uses a Star Rating Score (SRS) for all road users, reflecting the condition of safety-affecting road attributes. Road users encompass vehicle occupants, bicycles, and pedestrians. A comprehensive field survey and ViDA Software's star rating Excel sheets were used to evaluate road attributes on a 30-km road section from Faisal Mover's terminal, Islamabad, to Roomi Park, Islamabad. The survey identifies inadequacies in road safety, with the majority of sections having one or two stars for all road users. This indicates that poorly designed junctions and inadequate sight distances pose hazards and requiring for safer investment plans.

KEYWORDS: Road Users, iRAP Methodology, Road Protection Score, Start Rating, Road Infrastructure Elements, Safer Road Investment Plans.

1 INTRODUCTION

Population growth globally leads to increased road accidents, necessitating extensive efforts to prevent these complex injuries and ensure the safety of all individuals. Annually, 1.2 million fatalities and 50 million non-fatalities occur globally, necessitating global transportation departments to assess road quality to improve road conditions. Roads can be graded using a variety of techniques, such as the p-index, however the purpose of this newly introduce iRAP methodology is to mitigate the financial and societal effects of traffic accidents. The Euro, Australian, US, Kiwi, and Chinese RAPs make up iRAP and is an officially recognized non-profit organization whose mission is to reduce high-risk roads worldwide in order to save lives. The iRAP is still non-functional in Pakistan and many other low-income countries, where nine out of ten road accidents already occur. Pakistan is at the top of the list of nations experiencing an excessive number of fatalities as a result, Pakistan has an excessive need for road star ratings. In the Pakistan minimal prior research has been conducted on this subject and moreover pedestrian amenities are not a priority for road geometric designers, and the concept of star rating is also absent for both pedestrians and vehicles.



3rd International Conference on Advances in Civil and Environmental Engineering (ICACEE-2024)

University of Engineering & Technology Taxila, Pakistan

Conference dates: 21st and 22nd February 2024; ISBN: 978-969-23675-2-3

2 LITERATURE REVIEW

Traffic accidents result in over 1.5 million fatalities and 15 million injuries annually, highlighting the significant negative impact of road traffic on the environment.[1] The concept of star rating road is extended from NCAP (New Car Assessment Program). NCAP was adopted in the United States of America, Europe, Japan, and Australia for the star rating of cars based on their performance in crash tests.[2][3] The Euro RAP is a European road assessment program that was setup in 1999 to reduce death and serious injuries on the European roads after identifying the risk associated on the roads. [4] Similarly Aus. RAP is an Australian road assessment program that was established in 2005. [5] Similarly, US-RAP was established in 2004 for the star rating of highways located in the United States. iRAP stands for International Road Assessment program and was established to decelerate the cost that we encountered during the road accidents. iRAP model was initially derived in 2006 from the Euro rap and Aus. RAP. [6] The iRAP tool is now widely used in both developed and developing countries, as demonstrated in a case study in Bangladesh. The Italian major road network was rated using the iRAP/EuroRAP methodology, in which it was observed that with 63% of the network rated 1 or 2 stars for vehicle occupants, and for the motorbikes the severity of section is even more than 93%.[7] iRAP uses road star rating (SR) to measure road safety, based on estimated scores affecting road attributes, to design safer investment plans. [8] Studies showed that most of the highways in Bangladesh had a 2-star rating or less for road users and there is an intense need to improve the road attributes. [9] In India the Star Rating of roads benefited the authorities in assessing existing road safety levels, identifying targeted interventions, and evaluating road designs for economically viable safety treatments in upgrades.[10] Further study has also been done to analyse methodologies established by the International Road Assessment Program (iRAP) for network screening of road safety, focusing on collision records and physical attribute data. [11] The impact of geometric road attributes significantly influences traffic accidents, regardless of whether they are paved or unpaved. [12] A case study was conducted to evaluate the star rating of school walking routes to improve the safety perimeter of the school. [13] Similarly Road design criteria significantly impact traffic accidents, with speed of operating vehicles being the most crucial factor.[14] In Bangladesh the research was conducted on road infrastructure safety assessment using iRAP to address the safety challenges of vulnerable road users and to mitigate them to reduce traffic accidents and injuries. Similarly A case study was conducted to evaluate the star rating of pedestrian walking routes to improve safety measures on roads. [15] The majority of pedestrian accidents occur at road intersections, and even after traffic signals, the number of pedestrian-related accidents remains high. [16] The adoption of the star rating program in Denmark has significantly reduced pedestrian-related road crashes. [17] Limited research on road safety in Pakistan necessitates iRAP methodology implementation for safer investment plans in low and middle-income countries.

3 METHODOLOGY

Star Rating is a methodology that includes a measure of road safety about each road user which includes, pedestrians, bicyclists, motorbikes, and vehicle occupants ranging from one star (unsafe road) to five stars (safest road). It is measured based on over 50 road attributes (e.g. consisting of



3rd International Conference on Advances in Civil and Environmental Engineering (ICACEE-2024)

University of Engineering & Technology Taxila, Pakistan

Conference dates: 21st and 22nd February 2024; ISBN: 978-969-23675-2-3

lane width, shoulder width, median width, lateral clearance, delineation, number of lanes, and operating speeds) that influence traffic crashes or severity. The Star Rating is determined through an on-site survey using geo-referenced images and speed and traffic data. The 30 km stretch, starting from Faisal mover terminal to Roomi Park on National Highway N-5 passing through Islamabad, is divided into 30 sections. A 1 km road section is further divided into 10 sub-sections at 100 meters intervals. A survey is conducted on the worst-performing road section using a GPS tracker on a moving vehicle, Figure 1. All road attributes are recorded and stored in ViDA software to determine the Star Rating Score (SRS). Star rating score is the empirical measure of the liability and the severity of road accidents, dependent on the condition of road infrastructure elements, and is the foundation of the star rating and the safer roads investment plans.



Figure 1: Typical section of N-5 Highway rated 2-stars.

The star rating score, calculated for each user, and the higher the value of the star rating score indicates poor infrastructure condition, resulting in higher risks of injuries, crashes, and fatalities. The score is based on the worst 100-meter section of the road. The star rating is based on the relation between SRS and SR, which is listed in Table 1.

Table 1: Star Rating Bands (Lawson, 2011)

Star Rating	Star Rating Score		
User Types	Vehicle occupant and Motorcyclists	Pedestrians	Bicyclists
5	0 to < 2.5	0 to < 5	0 to < 5
4	2.5 to < 5	5 to < 15	5 to < 10
3	5 to < 12.5	15 to < 40	10 to < 20
2	12.5 to < 22.5	40 to < 100	20 to < 60
1	22.5 +	100 +	60 +

Table 1 shows that higher SRS values lead to lower star ratings, with worst road segments requiring proper infrastructure maintenance. Figures 2,3,4,5, and 6 display star ratings for all road users.



4 RESULTS AND DISCUSSION

4.1 Star rating for road users of northbound

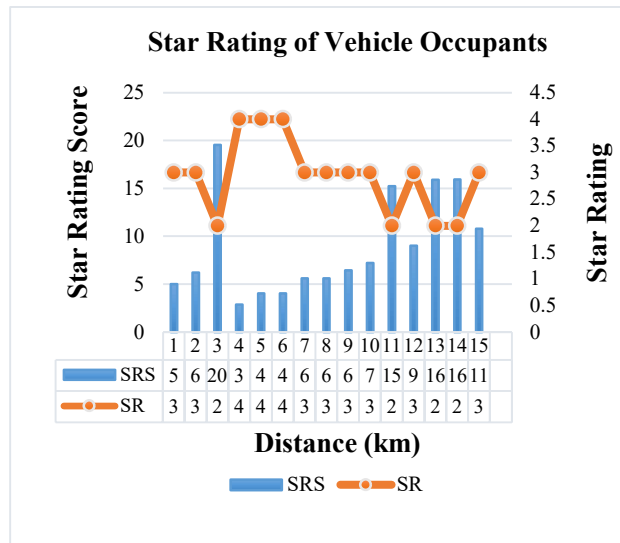


Figure 2: Star rating of vehicle occupants (N/B)

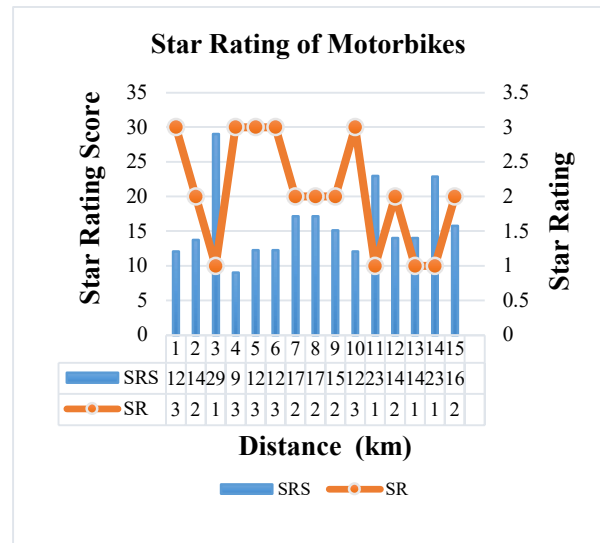


Figure 3: Star rating of motorbikes (N/B)

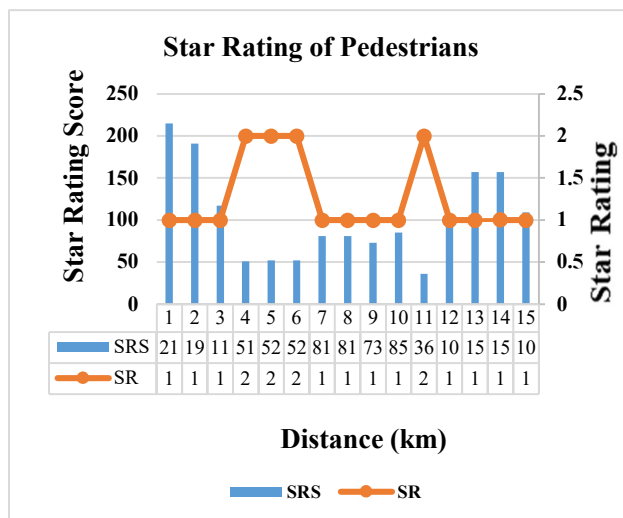


Figure 4: Star rating of pedestrians (N/B)

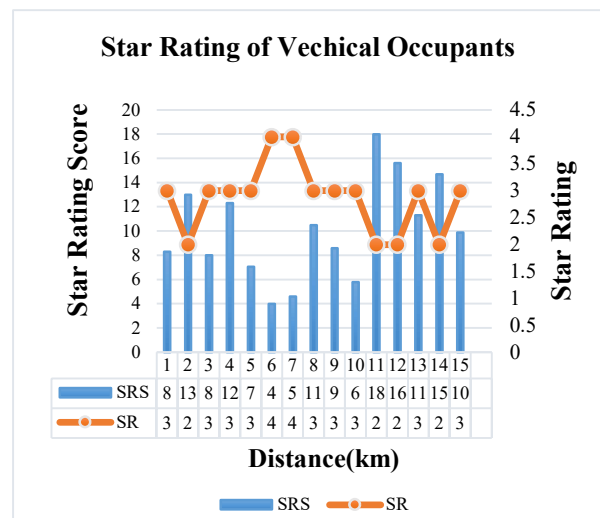


Figure 5: Star rating of vehicle occupants (S/B)



Figures 2, 3, and 4 show star rating values for northbound road and Figures 5, 6, and 7 show star rating values for southbound road against road protection scores.

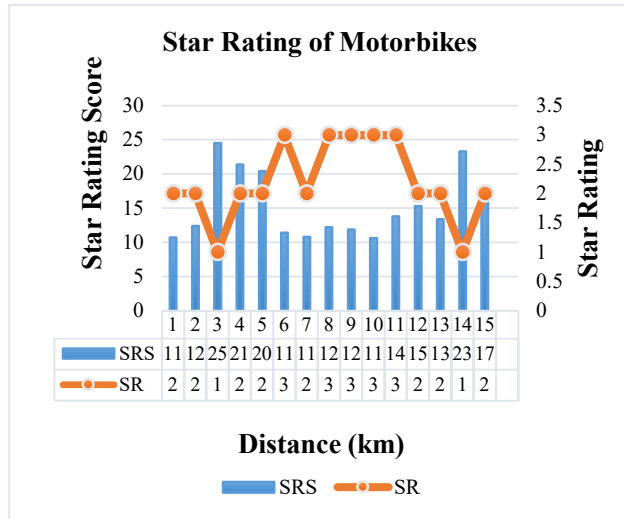


Figure 6: Star rating of motorbikes (S/B)

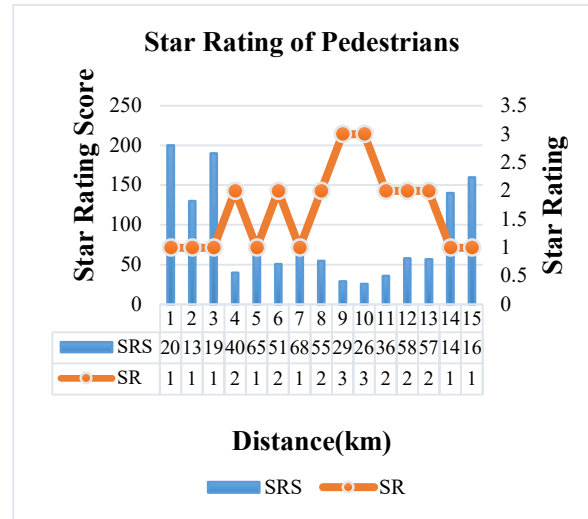


Figure 7: Star rating of pedestrians (S/B).

- Sections 4, 5 & 6 in (N/B) and sections 6 & 7 in (S/B) have 4 stars and are the best for vehicle.
- Sections 3, 11, 13, and 14 towards (N/B) while sections 2, 11, 12, and 14 towards (S/B) have 2 stars for vehicle occupants and are considered as worst sections.
- Even a single section towards (N/B) and (S/B) doesn't exhibit 4 or 5 stars for motorbikes.
- Sections 3, 11, 13, and 14 towards (N/B) while sections 3 and 14 towards (S/B) have 1 star for motorbikes and are considered as the worst section.
- Even a single section towards (N/B) and (S/B) don't have 4 or 5 stars for pedestrians.
- Merely section 9 and 10 in (S/B) have 3 star for pedestrians while all other sections towards (N/B) and (S/B) have 1 or 2 star for pedestrians and are considered as the worst section.

5 CONCLUSION

The following conclusions have been drawn from the results that were obtained after the star rating of an urban arterial road.

There was not a single section in (N/B) and (S/B) having 5 star for any road user, infect only three different sections each of one kilometer of a selected road segment have a four-star rating merely related to vehicle occupants, while all other sections have a three-star or less than three-star rating for all road users, therefore road infrastructure elements are required to modify for achieving 4 or 5 star related to all road users both towards (N/B) and (S/B) as guided in iRAP methodology.



3rd International Conference on Advances in Civil and Environmental Engineering (ICACEE-2024)

University of Engineering & Technology Taxila, Pakistan

Conference dates: 21st and 22nd February 2024; ISBN: 978-969-23675-2-3

REFERENCES

1. Lindov, O., et al. (2012). *Possibilities of Road Safety Assessment using EuroRAP Methodology on the Road Network in Urban Areas* Suvremeni Promet-Modern Traffic.
2. Hackney, J. R. and C. J. Kahane (1995). *The new car assessment program: five star rating system and vehicle safety performance characteristics*, SAE Technical Paper
3. Hobbs, C. A. and P. J. McDonough (1998). *Development of the European new car assessment programme (Euro NCAP)*.
4. Lynam, D., et al. (2004). *European Road Assessment Programme–EuroRAP (2003) Technical Report* EuroRAP May.
5. Metcalfe, J. and G. Smith (2005). *The Australian Road Assessment Program (AusRAP). Proceedings of Australasian Road Safety Research, Policing and Education Conference*, Wellington, New Zealand.
6. Harwood, D., et al. (2010). *Validation of US Road Assessment Program Star Rating Protocol: Application to Safety Management of US Roads* Transportation Research Record: Journal of the Transportation Research Board.
7. Daidone, L., Pagliari, E., Pennisi, L., Caporali, E., Mazzia, E., & Tiberi, P. (2023). *Road Infrastructure Inspections to Assess the Road Network According to the iRAP/EuroRAP methodology*. Transportation Research Procedia, 69, 743-750.
8. Jameel, A. K., & Evdorides, H. (2016). *An investigation for an all-encompassing iRAP road Star Rating index*. Functional Pavement Design, 1607-1616.
9. Hoque, M. M., Smith, G., Rahman, M. A., & Uddin, M. H. M. A. (2012, October). *IRAP and Road Infrastructure Safety Assessment in Bangladesh*. In Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand, Oct (pp. 4-6).
10. Bhavsar, J., Tharakan, A., Rogers, L., Smith, G., & McInerney, R. (2019). *Star Ratings for life-saving road improvements in India*. Transport and Communications Bulletin for Asia and the Pacific, 2030(89), 1-24.
11. Jane MacAngus, E., et al. *Risk Mapping and a Physical-Attribute-Based Star Rating System for Road Safety Network Screening Purposes on Canadian Prairie Region Highways*.
12. Ogden, K. (1997). *The effects of paved shoulders on accidents on rural highways*. Accident Analysis & Prevention 29(3): 353-362.
13. Logana, D., et al. (2013). *A model for star rating school walking routes*. Australasian Road Safety Research, Policing and Education Conference (Queensland Department of Transport and Main Roads 28-30 August 2013), Australasian College of Road Safety.
14. Rosen, E. and U. Sander (2009). *Pedestrian fatality risk as a function of car impact speed* Accident Analysis & Prevention.
15. Corben, K. and J. Goy *Star-Rating System for Pedestrian Walking Routes: A Pilot Study*
16. Garder, P. (1989). *Pedestrian safety at traffic signals: a study carried out with the help of a traffic conflicts technique*. Accident Analysis & Prevention
17. Jensen, S. (1999). *Pedestrian safety in Denmark*. Transportation Research Record: Journal of the Transportation Research Board.