THE UTILITY OF THE iRAP STAR RATING SYSTEM IN ASSESSING (AND POTENTIALLY CHANGING) THE SAFETY LEVEL OF RURAL ROAD INTERSECTIONS

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ABSTRACT

This study explores the effectiveness of the iRAP (international Road Assessment Programme) Star Rating System in assessing and improving rural road intersections, and specifically whether the simplest version of iRAP is of value in the South African context. iRAP assessments were compared with assessments and observations made at some length on site, to see whether the iRAP system sufficiently captured the most salient problems. Overall, the study showed that iRAP is a practical and effective tool which can be put to good use both to test the safety of intersections or road segments and, also, to experiment with potential interventions to see how safety can be improved most effectively.

1. BACKGROUND

It is a sobering fact that approximately 40 South Africans die each day on South African roads. It seems extraordinary that, in an age of technology and huge advancement in so many fields, the Global Status Report on Road Safety (WHO, 2018) recorded more than one million deaths and up to fifty million injuries per year on the world's roads.

The Constitution of the Republic of South Africa states that:

> "Everyone has the right to an environment that is not harmful to their health or well-being and to have the environment protected, through reasonable legislative and other measures that … secure ecologically sustainable development … while promoting justifiable economic and social development" (The Bill of Rights, 1996, 24).

A drive through the rural areas of South Africa highlights the fact that, unlike national roads and most urban roads, rural roads in many cases have yet to show evidence of the national progress envisaged by the South African Government. As a result, many rural communities remain in a state of economic and social deprivation.

Resource shortages are a key factor in the continued neglect of rural roads, and there is urgent need for cost effective ways of investigating the safety levels of roads in situ to be developed in order to come up with cost effective solutions. This research project evaluates the potential value of iRAP's star rating system (explained more fully in section 2.1) as a means of quickly and easily assessing road safety issues on South Africa's rural roads. In particular, this study looks at the use of the Start Rating system as a means of assessing safety of rural intersections. The star rating system has the benefit of not requiring crash data to assess the inherent safety of a road segment, and has potential, therefore, to be used even when crash data is poor or missing. The research applies the tool to a number of rural road sections in the Western Cape to determine whether the method has potential to be used more regularly as a quick and relatively easy method of determining relative degrees of safety on rural roads.

1.1 Road Safety as a Concern for South Africa

According to the Global Status Report on Road Safety (WHO, 2018), there were 14 071 reported road traffic deaths in South Africa in the year 2016, with an estimated road death rate of 25,9 per 100 000 population. The estimated total cost of road traffic crashes on South Africa's road network in 2015 was determined to be approximately R142,95 billion (representing 3,4% of GDP).

The National Road Strategy (2011) noted that the cost of maintenance, if delayed for 3 years beyond the recommendation date, escalates by a factor of 6, and that a further 3-year delay increases this factor to x18. Thus, delaying road maintenance to avoid expenditure is "false economy". Government, however, has insufficient funds to both maintain existing roads and carry out necessary expansion of the network.

Lack of funds for the maintenance of existing road infrastructure was raised as a concern by the South African Road Network Condition and Budget Needs Report in 2004 and again in their 2016 report (SANRAL, 2004, 2016) and the maintenance backlog included for both reports were considerable. According to the Draft Roads Policy for South Africa (DoT, 2017), inadequate funding for implementation and maintenance of road infrastructure remains a problem and, unless this situation changes, roads will continue to deteriorate.

The neglect of rural roads is not only a concern in South Africa. An OECD (1999) report reasoned that limited budgets for rural road maintenance and increasing traffic volumes would lead to an increase in incidental road maintenance over large-scale maintenance activities which would result in neglect of structural safety improvements.

1.2 Rural Roads

There is no international definition of the term 'rural', and no globally recognised road classification system. A rural area is defined by COTO (2012) as "any area not defined as an urban area, typically an area of sparse development, mainly given over to nature or farming activities" and an urban area is defined as "an area which has been subdivided into erven, whether formal or informal, including formal and informal rural settlements of one hectare or less". When a rural road enters an urban area, it becomes an urban road and when an urban road leaves an urban area, it becomes a rural road.

The basis of safe roads, according to the OECD (1999), is a consistent, hierarchal road network with each road assigned a specific function and designed according to its lowest functional use. Rural roads, however, tend to serve a variety of functions and carry a variety of traffic types. They also often tend to be inconsistent regarding elements such as width and gradient along their length, requiring constant speed adaptation which is not reflected in blanket speed limits. Inappropriately high speeds along these roads increase the opportunities for human error and this is often made worse by fatigue or intoxication. Factors such as limited right-of-way widths and roadside obstacles add to the dangers. Also, the OECD (1999) reported that rural road crashes were generally more severe, but their detection, and subsequent emergency response, was found to be slower than for crashes in urban areas.

Of all fatal rural road crashes, the OECD (1999) found 35% were single vehicle crashes (especially running off the road), contributed to by all three elements of risk: Vehicle, Driver and Roadway factors. An additional 25% of rural road crashes were head on crashes, caused primarily by some combination of driver and roadway factors, and about 20% were crashes at intersections, similarly caused by driver and roadway factors. The road environment was a contributory factor in all types, which led to a conclusion that the rural road system has inherent high-risk characteristics.

1.3 Rural Road Safety Problem in South Africa

Six years ago, then Transport Minister Peters (2013) identified inadequate rural transport development as one of the country's main problems and the Draft Roads Policy for South Africa 2017 (DoT, 2018) praised the condition of the national road network as good, expressed concern with the poor standard of many provincial and local roads and described rural road infrastructure as neglected. This was attributed to limited funding, lack of skills and prioritization of other needs over roads. The NDP 2030 (South Africa, 2012) identified rural access and mobility as "key policy and planning priorities" and urged roads policy for South Africa to take into consideration economic, social and environmental issues. Challenges regarding safe rural road networks, however, continue to impede economic, social and environmental development and this urgently needs to be addressed.

2. METHODOLOGY

2.1 The iRAP Star Rating System – Overview

Data collected by the WHO (2018) indicated that, in most countries, more than 50% of road deaths and severe injuries occurred on 10% of the road length. Identification of these high-risk road segments and dedicated funding to their upgrade was recommended and use of the Star Rating System was suggested. Global Voluntary Performance Target 3 calls for all new roads to achieve at least a three-star rating for all road users and Target 4 calls for at least 75% of travel on existing roads to meet similar requirements.

iRAP (the International Road Assessment Programme) was formed in 2006 by the British, Dutch and Swedish governments, and became a registered charity in 2011 (UK Registered Charity 1140257). It offers techniques to improve road safety in both urban and rural environments and especially for use in low- and middle-income countries, where detailed crash data might not be available. South Africa was one of the countries in which these techniques were piloted. According to iRAP (2019), the necessary research, technology and expertise to make roads safe already exist, and it aims to achieve Vision Zero (a road safety philosophy based on the objective of making all crashes survivable, thus preventing all road deaths) by widely sharing global expertise. The programme provides global metrics to measure safety performance, software to enable road assessments, and project support. Registration with iRAP is free and four protocols are available online:

- Star ratings: This system objectively measures the likelihood of a road crash occurring and of its likely severity, for all types of road users, based on identifying road attributes that influence the most common and severe types of crash. The online system requires extensive road attribute coding, using easily accessible data and geo-referenced images collected during road design or surveys of existing roads, to record a wide range of quantifiable attributes for each 100m segment of road, from which Star

Ratings are produced. For short lengths of road or single locations (100m segment), coding may be performed using the Star Rating Demonstrator. Five-star roads are the safest and one-star roads the least safe. iRAP (2019) maintains that death and injury rates are typically halved for each incremental improvement in star rating. All iRAP survey data from around the world is processed by a central data base called ViDA.

- Investment plans: These may also be generated using the uploaded data, based on optimisation of proven key attributes universal to all roads. More than 90 road improvement options are offered to cost-effectively improve the star rating of a road.

- Risk maps: These are a powerful road safety tool for use in regions where detailed crash data is available. Uploaded data is used to produce colour-coded maps indicating high-risk areas at a glance, including crashes per distance unit, crashes per road user group or crash type, and crash cost per distance unit.

- Performance tracking: This provides the means of monitoring the changing dynamics of road safety over time. Changes in economic activity, traffic volumes, urban density and other variables can be monitored.

2.2 Practical Application of the StarRating System in this Study

The iRAP system was used as a basis to evaluate the safety labels at six rural intersections, two of which are reported on here as examples. The iRAP analysis was accompanied by a detailed site investigation and traffic observation study, including the determination of conflict points. In so doing, it was possible to establish whether the iRAP analysis alone would be sufficient to assess the safety of an individual intersection, or whether a more detailed observation of traffic behaviour was necessary to identify factors that iRAP may miss.

Since only rural intersections were the points of interest, it was decided to use the online Star Rating Demonstrator. Features documented for this study, as illustrated in Figure 1, include:

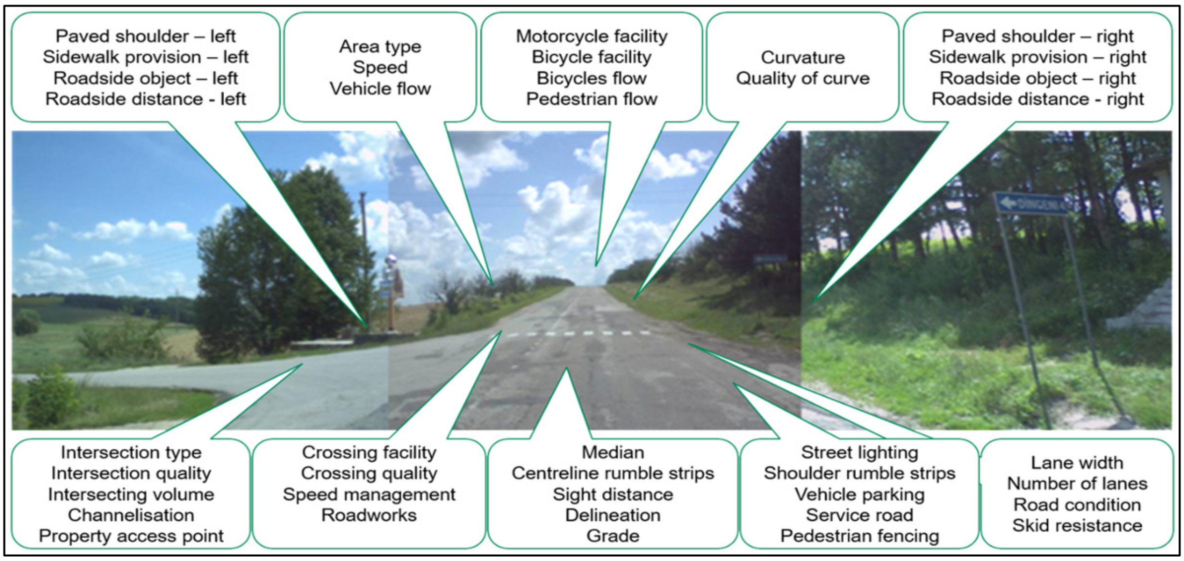

Figure 1: Road structure elements assessed (iRAP, 2019)

The information required was grouped onto 6 tabs as described below:

- Roadside: Required roadside information includes observation of roadside severity (hazards) and measurement of their distance from the road on both sides of the road. Sixty-two roadside objects are listed from highest risk (a cliff) to lowest risk (wire rope safety barrier). Other features are listed for potential inclusion or exclusion; for example, the presence or absence of paved shoulders and shoulder rumble strips must be noted, as must the quality of the road surface itself. Roads in poor condition (for example those with potholes) can be recorded as 'very poor'.

- Mid-block: This includes the number of lanes in each direction as well as lane widths, road curvature, curve quality, road gradient, and median type. The presence or absence of centre-line rumble strips, street-lighting, vehicle parking, service roads and road works must be noted. Other elements are road condition, skid resistance, delineation and sight distance.

- Intersections: Intersection type and quality must be noted, together with the type, or absence, of channelisation. Property access points at or near the intersection must be counted and described, and intersecting road volume measured.

- Flow: The AADT of the main through-road must be provided, together with information regarding pedestrian flow along both sides and across the road, and bicycle and motorcycle flow.

- Vulnerable Road User facilities and land-use: Information regarding the area type and land-use on both sides of the road is required, together with information regarding NMT and School Zone facilities.

- Speed: This grouping requires information regarding the posted speed limit, differential speed limits and speed management, and the operating speed which is represented by the 85th percentile.

Some of this data was easily available from road design plans and municipal records. Where it was not available from third parties, it proved straightforward to measure on site or from satellite imagery. Once all the required data had been accumulated, the Star Rating Demonstrator was used online to determine the star rating and risks for various road users at each location. Thereafter, experiments could be conducted by changing variables to discover which features could be changed to produce a higher star rating for the various road users.

2.3 Site Selection

Worldwide analyses of crashes have repeatedly confirmed that intersections are one of the most crash-prone elements of a road network (Anggraini & Oliver, 2019; Lord et al., 2007; Tay & Rifaat, 2007). In addition, interaction crashes on rural roads are more likely to be more serious and to result in fatalities than intersection crashes on urban roads (Tay, 2015) This contributed to a focus on intersections along rural roads. Due to space constraints, only two of the six studied intersections have been selected for this paper: the northernmost intersection of the R304 and the R101 (12.6 km north of Stellenbosch); and the intersection of the R45 and the R30 at Wemmershoek, between Stellenbosch and Franschhoek.

3. RESULTS

3.1 Intersection of R304 and R101

This is a staggered intersection separated by 520m, essentially operating as two separate intersections. For this report only the northernmost intersection has been included.

3.1.1 Overview

The R304 and R101 are both Class 2 rural roads (R2) with a mobility function, and Sandringham Road is a Class 4 collector road (R4) with an access function. This is an at-grade 4-legged full intersection as shown in Figure 2.

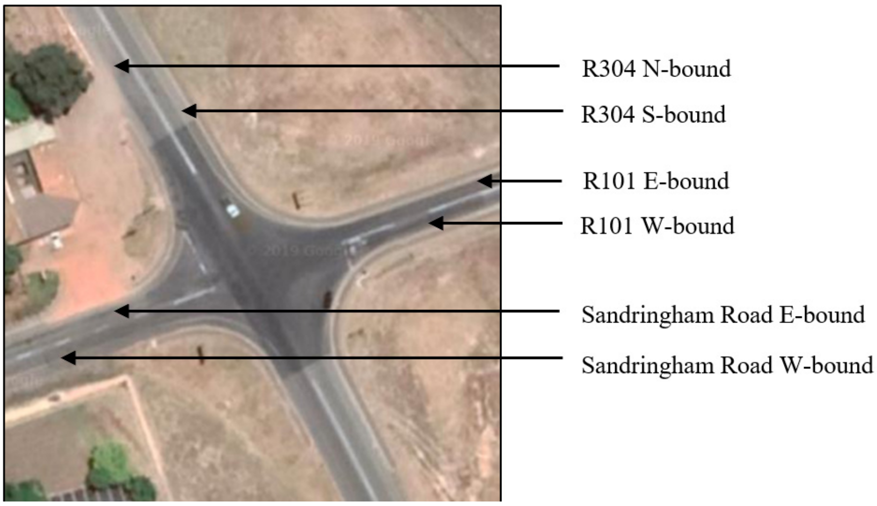

Figure 2: Northernmost Intersection of R304 and R101
(Maxar Technologies, AfriGIS, 2019)

3.1.2 Crash Data

According to municipal records, 16 crashes were recorded at the intersection from 21-02-2015 to 27-07-2019. Altogether 22 crashes, including these 16, were recorded over a 190m stretch between the two nearest nodes, 40m and 150m away.

3.1.3 Star Rating Assessment and iRAP Analysis

To conduct this study, speed limit, operational speed, AADT and peak NMT flow along and across the main through-road was required, together with AADT of the intersecting road.

- The posted speed limit along the R304 is 80km/h. The 85th percentile speed was found to be 80km/h and the average speed slightly lower at 72km/h. Similar speeds were recorded for N- and S-bound traffic.
- AADT for the R304 along this segment is 10 000-40 000 (RNIS, 2019), and AADT for this segment of the R101 is 1501-5000 (RNIS, 2019).

Data was entered into the iRAP Demonstrator and the star rating quantified (Figure 3).

This intersection was rated as 1-star for all road users at the intersection. The Global Voluntary Performance Target of 3-star rating is not met for any road users.

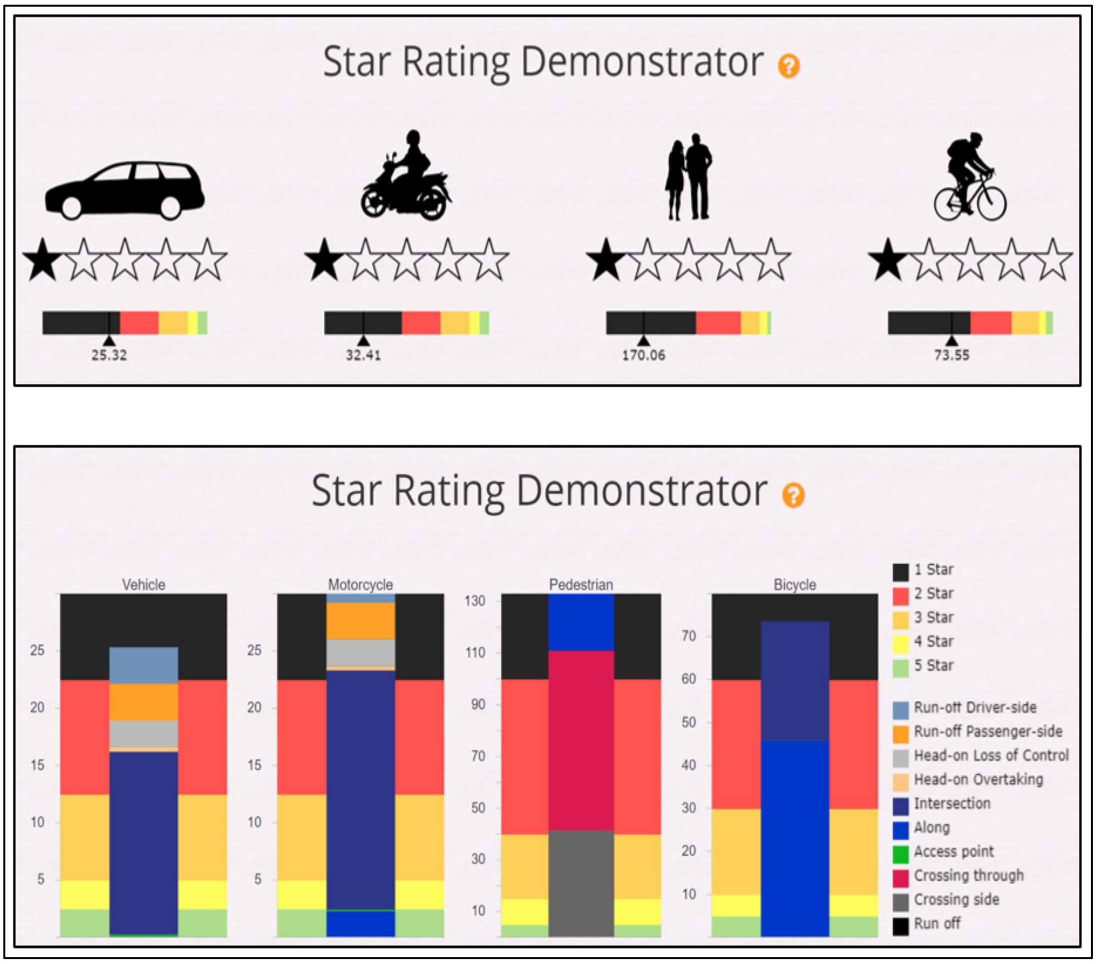

Figure 3: Star Rating & Risk Chart for N intersection of R304 and R101 (iRAP, 2019)

As an explanation of the risk chart, each of the four large blocks in the figure above represents risk for a specific road-user type using a road segment; vehicles, motorcycles, pedestrians and bicycles. The height of the narrower, central block within the large block indicates the star rating for that user type. Here, the first large block represents the crash risk for vehicles along this road segment. The narrower central block extends up into the black area which represents a star rating of 1-star. The colours within the narrower central block indicate which elements contribute to risk and, therefore, reduction in the star rating.

3.1.4 Experiments with Star Rating Exercise

Reducing the speed limit and operational speed through this intersection to 50km/h, as recommended by the Safe Systems Approach, would improve it to a 2-star rating for all road users except motorcyclists. Clearly the design of the 50km limit through intersections (as per Safe Systems guidelines) would need to be achieved with sufficient care so that speed differentials are managed, and approaching drivers are made aware of the reduced limit well in advance.

3.1.5 Data/Observations not required for the iRAP System

<u>a) Points of conflict study</u>:

This study revealed 12 possible legal manoeuvres and 32 resulting points of conflict at this intersection.

b) <u>On-site observed vehicle risks</u>:

- Although the lower end of the published AADT was used for star rating both roads, traffic volume was observed to be high both during the week and on weekends.
- Although the AADT from RNIS (2019) for Sandringham Road was 501-1500, there appeared to be an almost constant stream of vehicles, especially heavy vehicles. This road also seems to be part of a tour bus route.
- Although the operating speed was the same as the speed limit, this was considered inappropriate for passing through the intersection due to the lack of channelisation of vehicles slowing to turn. Traffic built up behind vehicles waiting to turn right from the R304 onto the R101, as shown in Figure 4 (left).

Figure 4: Traffic delays at N? intersection of R304 and R101 (2019)

- Long delays were observed for vehicles, especially longer heavy vehicles, waiting to turn left or right from R101 onto the R304, as shown in Figure 4 (right).
- High-risk overtaking was also observed on the S-bound R304 when vehicles slowed to turn left onto the R101.
- Twice, queues of vehicles were observed behind a slower heavy vehicle (measured at 50km/h once and 51km/h another time) and this resulted in some hooting – one queue was counted to be 23 vehicles.
- It was noted that, during lower traffic volume intervals, if one vehicle were recorded exceeding the speed limit then a few following vehicles would also be exceeding the speed limit.
- Motorcycles were recorded travelling at excessive speeds through this intersection.
- The road marking stop line where the R101 connects to the R304 is set far back causing some vehicles to edge forward for a better sight distance, and the sight triangle to the right is slightly obscured by the route information sign as shown in Figure 5 (left).

Figure 5: Examples of observed risk factors at N? intersection of R304 and R101 (2019)

- As is evident in Figure 5 (right), there is less distinct channelisation of vehicles turning left from the N-bound R304 than for those turning right from the S-bound R304 into the road leading to the weigh bridge north of the intersection. This potentially creates a build-up of traffic at high-volume times when a queue of heavy vehicles waiting at the weighbridge stretches back onto the R304.
- A variety of risks was observed to be associated with the shop parking area on the NE corner of this intersection.

c) On-site observed NMT risks:

- Although the nearby shop owner spoke of danger to pedestrians walking along and across the R304, few pedestrians were observed during traffic flow counts. Many were, however, observed walking along and across Sandringham Road.
- Due to the high traffic volumes and operating speeds, and the lack of NMT facilities, this was considered a high-risk intersection for NMT.

3.2 Intersection of R45 and R310

3.2.1 Overview

According to COTO (2012) description, these are both class 2 rural roads (R2) with a mobility function, and this is an at-grade 3-legged full intersection as shown in Figure 6.

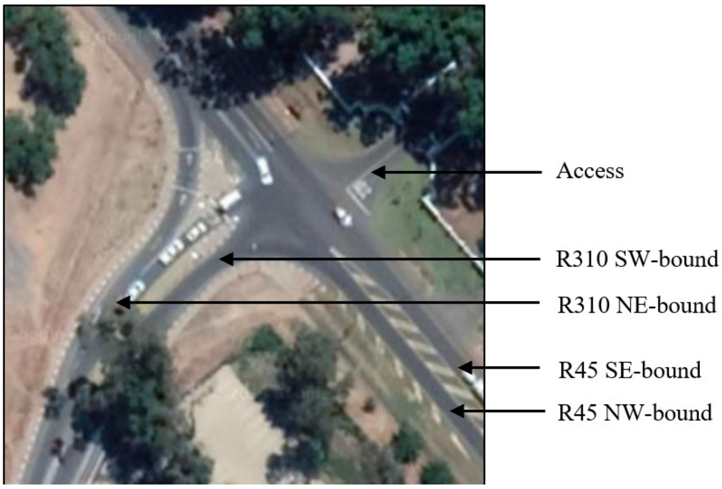

Figure 6: Intersection of R45 and R310 (CNES/Airbus, Maxar Technologies, AfriGIS, 2019)

3.2.2 Crash Data

No existing crash data for this segment of either of these roads could be accessed.

3.2.3 Star Rating Assessment

To conduct this study, speed limit, operational speed, AADT and peak NMT flow along and across the main through-road was required, together with AADT of the intersecting road.

- The speed limit is along the R45 is 100km/h. The 85th percentile speed was found to be 77km/h and average speed was calculated to be 64,62km/h. The speeds recorded in each direction indicated that SE-bound traffic travelled faster than NW-bound traffic (80 km/h compared with 72,8km/h).
- The AADT for the R45 along this segment is 5001-10 000 (RNIS, 2019), and AADT for this segment of the R310, is 5001-10 000 (RNIS, 2019).

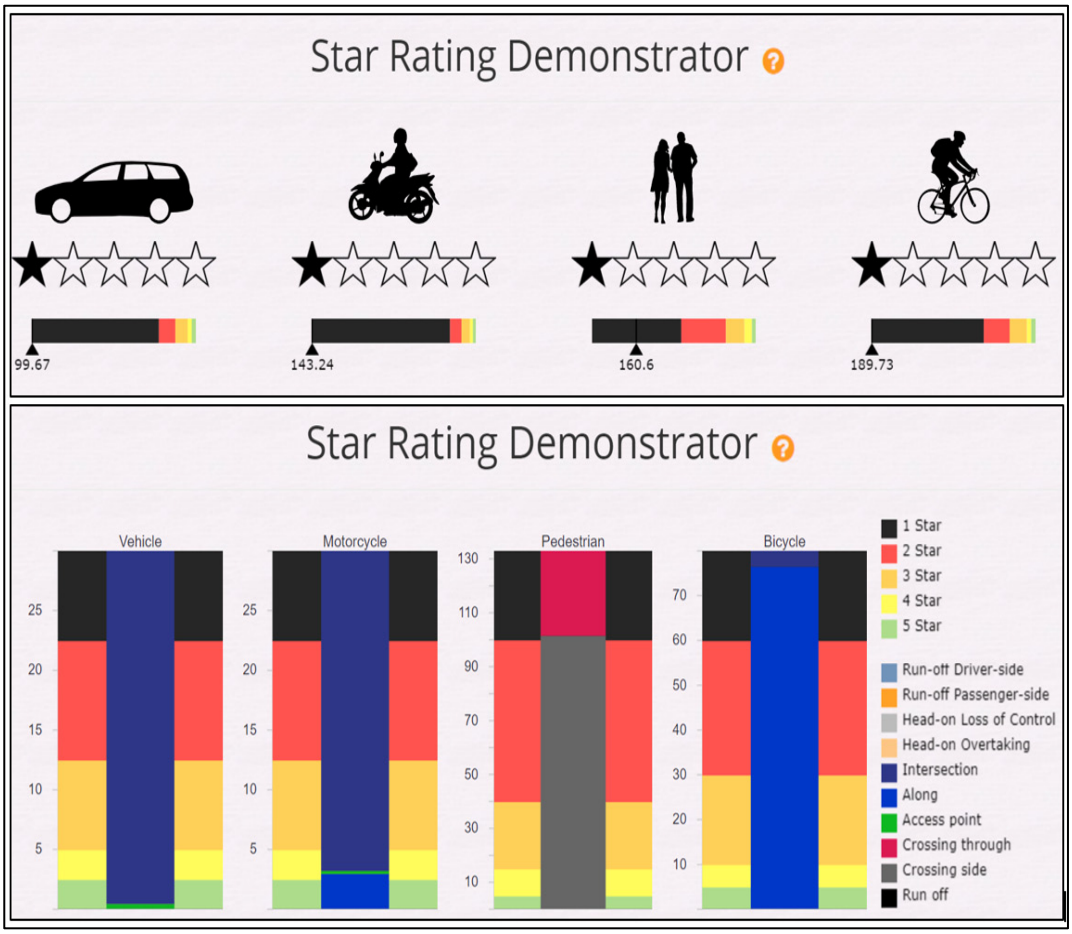

Figure 7: Star Rating & Risk Chart for intersection of R45 and R310 (iRAP, 2019)

Data was entered into the iRAP Demonstrator and the star rating quantified (Figure 7).

As with the previous example, this intersection scored a 1-star rating for all road users. Once again, the 3-star rating is not met for any road users.

3.2.4 Experiments with Star Rating Exercise

- The first site involved pedestrian facilities. To achieve a 2-star rating for pedestrians at this intersection would require construction of at least an unsignalized raised marked pedestrian crossing with refuge on both intersecting roads.
- The second site involved cyclists. Here the addition of just a shared use path would increase the rating for cyclists to 2-star.

3.2.5 Data/Observations not required for the iRAP System

a) Points of conflict study:

Although this is a 3-legged intersection between two R2 roads, due to observed traffic volume into and out of an access at the intersection, it was treated as a 4-legged intersection for the points of conflict study. This revealed 12 possible legal manoeuvres and 28 resulting points of conflict.

b) On-site observed vehicle risks:

- These roads were both observed to be high volume on both weekdays and weekends. The observed mix of vehicle traffic included private vehicles, heavy vehicles, buses and green tour tram-buses, taxis, an ambulance, and vehicles towing horseboxes, boats and trailers.

- The property access right at the intersection, shown in Figure 8 (left), appeared relatively busy compared to other access roads observed, both on weekends and weekdays, with private vehicles and tour buses entering and exiting. Some of this access use required a weaving movement across the R45 directly to or from the R310.

Figure 8: Examples of observed risk factors at intersection of R45 and R310 (2019)

- The SE-bound R45 has a significant edge drop-off, shown in Figure 8 (right).
- Of concern was the number of vehicles, especially taxis, that stopped on the R45 roadside, both NW- and SE-bound, causing traffic to manoeuvre around them. This presented a particularly high risk when vehicles turning left from the R310 onto the R45 encountered a stopped taxi just after the turn.
- Although the speed limit through this intersection is 100km/h, as typical for rural mobility roads, and the 85th percentile was 77km/h, neither appeared appropriate for this high-volume intersection. Both exceed the Safe Systems recommendation of 50km/h through intersections, and the even lower recommendations for mixed vehicle traffic and NMT.
- Despite some channelisation, dangerous overtaking manoeuvres were observed.

c) On-site observed NMT risks:

- Many pedestrians were observed walking along both roads and crossing in both directions over both roads.
- Pedestrians also wait on both sides of the R45 for transport, both private and taxis.
- Tourists were observed taking photographs on the road edge at the access entrance.
- Groups of cyclists were observed using both high-volume roads, especially at the weekend, sometimes causing vehicles to cross the median to overtake.

4. DISCUSSION: STRENGTHS AND WEAKNESSES OF THE iRAP AS TESTED

4.1 Immediate Access to Free Global Expertise

Registration for the use of iRAP and ViDA software is free and provides instant access to a wealth of online resources and tools for safety assessment and improvement of both road designs and existing roads based on global expertise. Training is offered and unlimited access is provided for consultation with experts. This system is constantly updated in accordance with the most recent research.

4.2 Comprehensive and Flexible Software

4.2.1 ViDA

The database provides for the upload of road survey data, including images, which allows for data storage, information sharing and the generation of risk maps, customised investment plans and progress tracking. Of particular benefit are:

- Risk maps: Existing risk maps were found to provide the current risk status of, and other statistics regarding, segments of roads that have been assessed.
- Investment plans: It was possible to generate Investment Plans for isolated road segments or entire road networks, taking into account factors such as existing road features, traffic speed and volume, hierarchy of potential treatments together with projected fatalities and injuries before and after each possible treatment or combination of treatments, and projected economic benefits of investing in a specific treatment, including benefit to cost ratio and internal rate of return. User-defined investment plans could be developed, and countermeasures tailored to suit individual circumstances and priorities.
- Progress tracking: The permanent storage of data was found to facilitate data recall, update and comparison. This allows for easy progress tracking so that timeous countermeasures may be employed, or successful improvement highlighted.

4.2.2 Demonstrator

Data collected for the initial project was uploaded to the Star Demonstrator. This was suitable for the project focus and still provided access to most of the iRAP information and expertise. Use of the Star Demonstrator instead of the full ViDA software had advantages and disadvantages.

Advantages were as follows:

- Ease of application: Although training is offered free online, this was not essential as the provision of information sheets and comprehensive guides ensured that data collection was straight forward and relatively easy.
- Material resources: Use of the Star Demonstrator required minimal equipment – internet access, transport to sites, a speed gun, a measuring wheel and prepared sheets for recording observations and measurements. A camera was helpful but not a necessity.
- Human resources: Full ViDA software should be conducted and collated by a trained team and data checked for accuracy and consistency before upload. Assessment for use of the Star Demonstrator, however, can quite feasibly be conducted by a single untrained individual.
- Instant results: The simplicity of the Star Demonstrator meant that as soon as all required data was gathered it could be uploaded and star ratings immediately produced. Experiments with input variables could immediately be conducted and the potential impact on safety of countermeasures compared.

Disadvantages were as follows:

- Limitations: The Demonstrator allows for assessment of a single 100m stretch of road at a time.
- Lack of permanence: Unlike data uploaded to ViDA, data uploaded to the Star Demonstrator is not permanently stored on the system.

- Inability to generate risk maps and investment plans: Unlike the full ViDA software, use of the Star Demonstrator meant that risk maps could not be automatically produced, and cost-benefit investigations had to be manually conducted.
- Not accessible online: The temporary nature of the data uploaded to the Star Demonstrator means that it cannot be accessed online.

4.3 Utility in the South African Rural Context

Historically South African rural roads have often been overlooked, not only in terms of resource allocation and maintenance, but also in terms of investigation and research. A problem encountered during the original project was the inadequacy of current collection, storage and accessibility of crash data regarding these rural roads. The iRAP system, however, caters for both urban and rural environments, allowing for unique circumstances and challenges that might be faced in developing countries. For example, application of the system does not rely on existing crash data and countermeasure plans can be tailored to budget and priorities.

The Star Demonstrator proved to be an extremely effective and cost-effective system for determining safety risk and potential countermeasures associated with specific road segments, particularly useful for recognised high-risk elements such as intersections or schools. Since no permanent online record is generated, its use would mainly be recommended for such specific locations where a problem is recognised or suspected and an immediate improvement is planned.

Although slightly more complex, for longer stretches of road, and where resources allow, use of the full ViDA software rather than the Star Demonstrator, is highly recommended. This provides a comprehensive overview of the current situation and a clear idea of what would be required to meet globally recognised road safety standards. It also generates detailed investment plans that can be adapted to circumstance. Furthermore, it allows for regular updates of data and the generation of risk maps so that current information is accessible to all concerned. The development of a comprehensive and accessible database would be particularly desirable in the South African context where it could potentially compensate for the previously mentioned lack of reliable crash data.

4.4 Utility as a Stand-Alone Technique

The original project indicated that, in investigating road safety, all the available tools and techniques combined could not infallibly account for every potential human error or high-risk situation. This suggests that on-site observation by an informed individual is an essential element of site analysis. Even the Star Rating System proved unable to predict all possible risks. However, in most cases this system presented the worst-case scenario, was found to produce an tolerably accurate assessment of risk and was extremely useful when investigating potential countermeasures.

Whilst on-site observation techniques would be strongly recommended as an addition to use of the iRAP Star Rating System, the following is noted:

- Although on-site observation did, on occasion, identify an unpredictable risk overlooked by the Star Rating System, generally observed risks and conflict points could be attributed to structural deficiencies highlighted by the system. Thus, in most cases, the system was considered to corroborate and/or explain observed risks.

- Data required for the Star Rating System is comprehensive and diverse and requires more than one site visit. Data-gathering by a single individual, therefore, ensures familiarity with the location and increases the likelihood that unusual or unpredictable risk factors might come to the attention of an observant investigator.
- Collection of certain data, such as recording measurements and the absence or presence of structural elements, requires no interpretation and can be allocated to untrained personnel. Other required data, however, demands some understanding of road safety concepts and the quality of this input data impacts the quality of the output ratings.

Assuming that input data is mindfully gathered and collated by an observant and informed individual, the iRAP Star Rating System, even as a stand-alone technique, provides an accurate and comprehensive overview of risk status, together with potential countermeasures and their predicted impact on road safety.

5. CONCLUSION

The continued high road crash rate both globally and in South Africa is particularly perplexing in the light of widespread awareness of the problem and the wealth of research and information freely available online. Having investigated the iRAP resource along some of the Western Cape's rural roads, its use is highly recommended in the South African context. Although the system cannot capture unique events or hazards that a trained observer might, the research found that the system was generally conservative enough to accommodate the effects of even unexpected events.

Overall, this system provided the means to identify, and even suggest solutions for, most high-risk factors at the chosen locations. It is well suited for application on South Africa, given that it does not require crash data, and also that the roadway data it requires as a basis is accessible even remotely, using electronic and satellite images. Although site inspections will always provide valuable observational data, the IRAP star rating's conclusions were shown, across all six location in the wider study, to produce acceptable and usable assessments of safety risk.

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