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Evaluation of Effectiveness and Benefits of iRAP and Bina Marga Methods for Road Safety Assessment on the Karanglo-Bts. Kota Batu (Karang Ploso) Segment

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Abstract

According to Road Safety (2002), traffic accidents result from vehicles, humans, road environments, and their interactions. Addressing these issues is crucial for improving road safety, particularly for operational roads and those under maintenance, to prevent recurring accidents in the same locations. This study examines the effectiveness and benefits of two road safety assessment methods: the iRAP ranking analysis method and the Bina Marga ranking analysis method. The Karanglo–Batu City Border (Karang Ploso) road segment, spanning 7.99 km, was selected as the study area. Both methods analyze five key accident types: roadway departure, head-on collisions due to loss of control or overtaking, intersection accidents, and accidents at property access points. Factors influencing these accidents include probability, severity, operational speed, external traffic, and median traversability, with star ratings assigned based on the Star Rating Score (SRS). The iRAP method, utilizing the iRAP Demonstrator application, yielded an SRS score of 8.92 (3 stars), while the Bina Marga method, using manual calculations as per the Road Environment and Safety Guidelines Number 06/P/BM/2024, produced a score of 7.13 (3 stars). After implementing rehabilitation recommendations, both methods improved the score to 2.78 (4 stars). Effectiveness values were 35.68 for iRAP and 31.69 for Bina Marga, both categorized as effective. Post-improvement, the effectiveness value was 12.36, categorized as very effective. The iRAP method demonstrated higher direct benefits, particularly in data input, sampling, and implementation, making it more suitable for precise safety assessments.

Keywords*: Road Functional Feasibility Assessment, ULFJ, iRAP, Star Rating*.

INTRODUCTION

According to Road Safety 2002, traffic accidents are influenced by several factors: vehicles, humans, and road environments, as well as the combination and interaction of these factors. Therefore, to improve road safety for operational roads and those under maintenance, it is important to identify road safety issues and address them to prevent recurring accidents on the same road sections and locations (Jaya et al., 2023; Setyorini & Iskandar 2023). To meet the service level requirements of the provincial road network in East Java, both for current and future needs, while minimizing costs and risks, it is essential to implement Road Infrastructure Asset Management that adheres to good infrastructure asset management principles. According to the Regulation of the Minister of Public Works and Housing of the Republic of Indonesia, Number 4 of 2023 on Guidelines for Road Function Feasibility, Road Function Feasibility refers to the condition of a road segment that meets the technical feasibility requirements to ensure safety and security for its users, as well as administrative requirements that provide legal certainty for both road operators and users, allowing the road to be operated for public use.

To meet the technical requirements for Road Function Feasibility, the Road Function Feasibility Testing Team has several responsibilities, including assessing compliance with the technical specifications based on Star Rating and providing necessary rehabilitation recommendations, especially for road segments with low star ratings. As outlined in the appendix of Presidential Regulation No. 1 of 2022, the goal for Pillar 2 by 2030 is that all new roads must meet safe technical standards and achieve a star rating of 3 or higher. Additionally, 75% of motorized vehicles should travel on existing roads that meet 3-star road standards, based on the International Road Assessment Programme (iRAP) assessment approach (Murozi et al., 2022). There is a positive correlation between the iRAP Star Rating Score (SRS) and safety performance indicators, with higher SRS values corresponding to higher hazard levels and elevated safety performance indicator values (Ayuningtyas et al., 2024). The context and human elements not explicitly considered in the iRAP methodology are needed to refine these findings and address the contextual limitations (Pernetti et al., 2024)

This study aims to determine the effectiveness of road functionality tests and the benefit values between the iRAP method and the Bina Marga method as materials for future evaluations. The road section selected for this research is the Karanglo-Batu City Border (Karang Ploso) road segment, with a length of 7.99 km. iRAP, the International Road Assessment Programme, is a global charitable organization committed to saving lives by addressing and eliminating high-risk road deficiencies worldwide. The iRAP method can assess high-risk roads, and develop star ratings, risk maps, and investment plans for safer roads. This approach also facilitates countermeasures for road segments that have not yet achieved 4- or 5-star ratings (Daidone et al., 2023).

METHOD

iRAP Star Rating Analysis Method and Bina Marga Method (SRS)

Star Rating is a road safety performance assessment method that assigns ratings based on the condition of road infrastructure elements. The star rating utilizes data from road safety inspections and the relationship between road attributes and accident rates. The final result of the star rating ranges from 1 star to 5 stars (Sharma et al., 2023), determined through the classification of the Star Rating Score (SRS). The SRS value is calculated based on the road being analyzed, divided into segments of 100 meters each.

The Star Rating Score (SRS) is influenced by five (5) types of accidents: Accidents caused by leaving the roadway, Head-on collisions due to loss of control, Head-on collisions due to overtaking, Accidents at intersections, and Accidents at property access points.

Based on the formula for calculating the Star Rating Score (SRS), each type of accident is influenced by the following factors: probability, severity, operational speed, external traffic influence, and median traversability.

The data collection technique used is observation. According to Bungin (2005), observation is utilized to obtain research data through a series of observations that rely on the researcher's senses or direct measurements in the field. Based on this definition, there are several key points that the researcher will observe, namely: (1) The effectivity of road function feasibility testing using the ranking analysis method; and (2) The benefit value of road function feasibility testing between the iRAP ranking analysis method and the Bina Marga ranking analysis method.

The Bina Marga Method evaluates the functionality and quality standards of roads based on various factors, including personnel competence, administration, and construction implementation quality. This assessment aims to map the construction quality of roads in each regional office, serving as a basis for internal evaluations and formulating development strategies within the Directorate General of Highways. Meanwhile, iRAP evaluates road safety internationally based on the physical characteristics of roads. This program develops internationally applicable road safety assessment methods, considering road infrastructure elements to determine risk scores and star ratings. The Bina Marga Method evaluates the functionality and quality standards of roads based on various factors. iRAP assesses road safety internationally based on the physical characteristics of the road (St. Maryam et al., 2023).

Technical Provisions

Steps for Using the iRAP Demonstrator Application: (1) Activate iRAP Demonstrator User; (2) Collect Image Data with Geo-reference; (3) Determining the Starting and Ending GPS Coordinates, and the Route Used; (4) In the iRAP Demonstrator, the Star Rating Demonstrator contains 7 tabs, which are typically used to input various types of road and safety data for evaluation. Here is an overview of the common tabs in the Star Rating Demonstrator: Standard Cross Section (Cross-Section Type), Roadside, Mid-Block, Intersection, Traffic Flow, VRU Facilities and Land Use, and Speed Limits. From all of the aforementioned steps, all data is uploaded through the iRAP website for analysis calculation.

The Bina Marga method for calculating the Star Rating Score (SRS) takes into account five (5) types of accidents, which are: (1) Accidents caused by leaving the roadway; (2) Head-on collisions due to loss of control; (3) Head-on collisions due to overtaking; (4) Accidents at intersections; and (5) Accidents at property access points. The formula for calculating the Star Rating Score (SRS) generally includes the following factors as shown in Equation 1.

$$SRS = SRSRun\text{-}off + SRSHo\text{-}Loc + SRSHo\text{-}ot + SRSInt + SRSPa \quad (1)$$

Explanation

, SRS is Star Rating Score

, SRSRun-off is Star Rating Score Run-Off

, SRSHo-Loc is Star Rating Score Head-on Loss Control

, SRSHo-ot is Star Rating Score Head-on Overtaking

, SRSInt is Star Rating Score Intersection

, SRSPa is Star Rating Score Property Access

According to Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat (PUPR)

Nomor 4 Tahun 2023, concerning the Guidelines for Road Functionality Testing (Pedoman Laik Fungsi Jalan), roads are classified into four (4) minimum functionality categories, as detailed in Table 1 (referenced within the regulation).

Table 1. Star Rating Categories

Star Rating Categories	Scores	Colour Categories
5-Star	0,0 s.d. < 2,5	Green
4-Star	2,5 s.d. < 5,0	Yellow
3-Star	5,0 s.d. < 12,5	Orange
2-Star	12,5 s.d. < 22,5	Red
1-Star	≥ 22,5	Black

Here's an explanation of each Star Rating Category based on the road safety standards outlined in the Peraturan Menteri PUPR Nomor 4 Tahun 2023 and commonly used road assessment systems: (1) 1-star category is a very high risk, roads rated 1-star are considered to have a very high risk for accidents; (2) 2-star category is a high risk, Roads in the 2-star category still present a significant risk to road users, though slightly lower than 1-star roads; (3) 3-star category is a moderate risk, A 3-star rating indicates moderate risk. These roads are relatively safer but still have areas that could be improved; (4) 4-star category is a low risk, Roads with a 4-star rating offer a relatively safe environment for users; (5) 5-star category is a very low risk, Roads rated with 5 stars represent the highest safety standard.

Analysis and Programming

The effectivity value is evaluated using the ratio method. In the effectivity evaluation using the iRAP analysis method, the survey rating value represents the current condition based on survey results, while the standard rating refers to the predefined threshold. Thus, the effectivity value can be evaluated using the following Equation 2.

Effectivity Value (E) iRAP Analysis Method= (Δ iRAP)/(Δ Standar) x 100% (2)

The effectivity value using the SRS analysis method (Bina Marga method) can also be evaluated by comparing the survey rating value (current condition) and the standard rating value (predetermined threshold). The effectivity value can be calculated using the following Equation 3.

Effectivity Value (E) SRS Analysis Method = (Δ SRS)/(Δ Standard) x 100% (3)

In the effectiveness category, an interval scale can be applied. The proposed effectivity categories are divided into five categories, as follows : (1) Very Ineffective (0% - 19%); (2) Ineffective (20% - 39%); (3) Moderately Effective (40% - 59%); (4) Effective (60% - 79%); dan (5) Very Effective (80% - 100%). The smaller values indicate less effectiveness and larger values indicate greater effectiveness of the method. The interval factor serves as a consideration in an evaluation. It is understood that the interval factor is calculated by subtracting the minimum value from the maximum value and dividing it by the number of intervals. According to Wijaya (2009), an interval represents an estimated assessment and the difference between the maximum and minimum values compared to the number of classes (Odeck & Kjerkreit, 2019).

The formula for calculating the interval is shown in Equation 4.

Interval = (Maximum Value - Minimum Value)/Number of Intervals (4)

The maximum effective value is set at 100%, while the minimum value is 0%. The total number of intervals corresponds to the total number of sampled segments in the population (i.e., the total road segments). Therefore, the assessment interval is defined as (100–0)/5(100 - 0) / 5(100–0)/5, resulting in a value of 20% per interval (Ineffective).

To determine the benefit value can be identified from the change in benefit value as shown in Equation 5 and Equation 6, respectively, explanation, Δ iRAP is the Total iRAP Rating Score, and Δ SRs is the total Bina Marga Rating Score.

$$\text{SRS Benefit Value} = \Delta\text{iRAP} - \Delta\text{SRS} \quad (5)$$

$$\text{iRAP Benefit Value} = \Delta\text{SRS} - \Delta\text{ iRAP} \quad (6)$$

A positive benefit value (+) indicates the presence of benefits, while a negative benefit value (-) indicates a lack of benefits. In such cases, the evaluation method can be assessed to determine whether it is efficient using the chosen method.

RESULT AND DISCUSSION

iRAP Analysis

The study highlights the importance of using the empirical Bayesian method to identify high-risk road sections, prioritize inspections, and adjust Safety Potential to local conditions and accident trends. Based on the iRAP analysis, the total Star Rating Score obtained is 6.53, placing the Karanglo-Batu segment in the 3-star category, close to the 4-star category, with an orange colour classification, indicating that the road segment is reasonably safe. The application of the Empirical Bayesian method, enhanced by the Proportion Discordance Ratio, can predict the number of accidents likely to occur on road segments. This methodology allows for an objective assessment and measurement of similarities between different road segments (Lee et al., 2019). Exploring an alternative approach to iRAP Star Rating validation, the proposed method demonstrates feasibility, with results confirming a correlation between improved Star Ratings (Ambros et al., 2017). The iRAP Star Rating is widely recognized as the most comprehensive, measurable, and reliable indicator of safer mobility. Key indicators of safer road user behavior—such as speed management, use of restraint systems, and avoidance of mobile phone use while driving—were selected for analysis (Jameel & Evdorides, 2023).

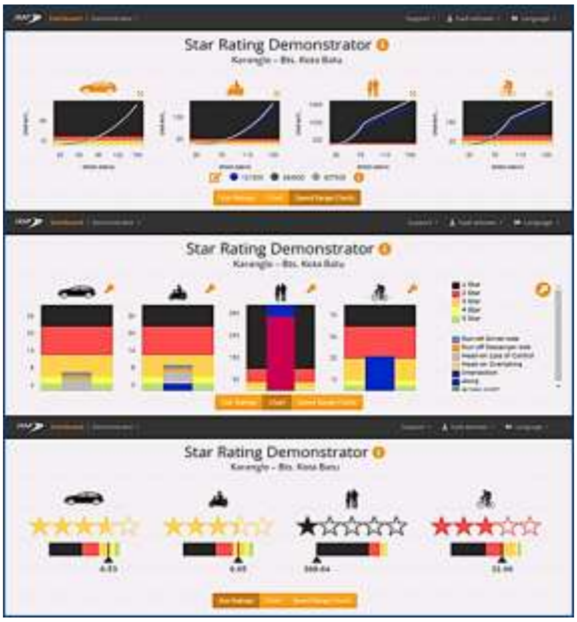

Figure 1. Recapitulation of iRAP Demonstrator Results

Bina Marga Analysis

The road assessment segments are determined by the physical uniformity of every 100 meters. The Karanglo – Bts. Batu City (Karang Ploso) road section, there is physical non-uniformity, such as significant changes in lane width or road configuration, which result in the division of the road into 5 continuous segments over 7 km, as shown in Table 2. The surveyed road segment has a total length of 7,989 meters, all surfaced with asphalt. No other surface types, such as concrete, gravel, or soil, were recorded, indicating uniform road construction material. The road is divided into five segments, with the majority of the length (7,200 meters) concentrated in Segment 3. This indicates that most of the road's coverage is uninterrupted by intersections or significant changes in road type. The road width varies across segments, with the widest portion (19.6 meters) located in Segment 1 and the narrowest (9 meters) in Segment 5. Such variations could influence traffic flow and safety dynamics in different segments. The geographical coordinates provide precise mapping of the road from start to finish, useful for further geospatial analysis and monitoring. In summary, the Karanglo–Batu City Border (Karang Ploso) road segment features a continuous asphalt surface, varying widths, and a predominantly lengthy Segment 3, necessitating targeted analysis for traffic and safety assessments.

On the other hand, an example of attribute assessment for Segment 1 of the Karanglo – Bts. Batu City (Karang Ploso) road is shown in Table 3. This table comprehensively evaluates various aspects of the road segment Karanglo-Bts. Kota Batu (Karang Ploso). The detailed identification supports traceability and precision in road evaluation with a daily vehicle flow of 5,783 vehicles, suggesting moderate traffic density. This data indicates the road's usage intensity, important for safety considerations.

Table 2. Survey Table for Karanglo – Bts. Kota Batu (Karang Ploso).

Road		km			Long segment (m)	A: aspal B: beton K: kerikil T: Tanah	Length (m)	Koordinat	
Number Road	Name Road	Segment Number	Sta Start	Sta End				Start	End
021	Karangglo-BTS. Kota Batu (Karang Ploso)	1	0	200	200	A	19,6	-7.91164 ; 112.65269	-7.91559 ; 112.65269
		2	200	300	100	A	15,4	-7.91559 ; 112.65269	-7.91496 ; 112.65206
		3	300	7500	7200	A	9,1	-7.91496 ; 112.65206	-7.89471 ; 112.59391
		4	7500	7700	200	A	10,4	-7.89471 ; 112.59391	-7.89674 ; 112.59088
		5	7700	7989	289	A	9	-7.89674 ; 112.59088	-7.89290 ; 112.59234

The operational speed (40 km/h) is below the limit (60 km/h), indicating potential speed compliance or slower flow due to conditions. The presence of traffic calming measures and differential speed limits enhances safety for varying road users. It's an undivided road with four or more lanes, adequate lane width (≥3.25m), and a straight alignment. The road is paved with adequate skid resistance, good condition, and adequate sight distance and delineation. Safety features like centerline rumble strips and frontage roads are missing. While the design supports efficient traffic flow, the absence of these features may compromise safety in certain conditions.

The severity and object proximity of roadside features include many trees with diameters ≥10 cm located within 1–5 meters on both sides, increasing the risk of severe accidents in case of vehicular departure. Paved shoulders of 1–2.4 meters exist on both sides, but rumble strips are unavailable. While adequate shoulders provide some safety margin, the tree proximity and lack of rumble strips pose risks to drivers. The road passes through a commercial urban area, further elevating pedestrian activity. There are crosswalks with traffic islands and a Zebra Crossing with signage, but sidewalks are only present on the passenger side and are narrow (0–1m). The limited infrastructure partially addresses safety but needs improvement, especially in providing wider, more consistent sidewalks. Adding tactile paving can enhance accessibility for people with disabilities, ensuring safer pedestrian paths (Hetyorini et al., 2023). The road includes lane merging, channelization, and good quality, with access to several commercial properties. Traffic volume at intersections is high (5,000–10,000 vehicles/day).

The intersection design and volume suggest potential congestion and risks, necessitating traffic management measures. The assessed road segment has several positive attributes but would benefit from additional safety enhancements to better protect pedestrians and reduce collision risks in high-traffic areas. After the attribute assessment was conducted on Segments 1 (one) to 5 (five), the results are summarized in Table 4. This table evaluates existing road conditions for several segments, assigns a rating score, and provides recommendations for rehabilitation to enhance safety. The table consists of 5 road segments, varying in length from 100 meters to 7,200 meters. Each segment is assessed for its current safety rating score and the anticipated improvement score after implementing the recommended measures. Ranges from 6.18 to 7.20 indicate suboptimal safety performance, while improvements range from 2.67 to 2.97, showing significant safety gains after implementing the suggested measures.

General recommendations across segments include adjusting operational speeds to different limits. Speed management engineering focuses mainly on speed control measures or signs, hardened and widened shoulders, and increased roadside object spacing to reduce risks from fixed hazards. The highest initial scores (7.20 and 7.17) indicate the need for comprehensive interventions. Speed management and roadside safety measures resulted in improved scores of 2.67 and 2.78. Improved speed management and shoulder width showed further improvements, with scores of 2.69, 2.93, and 2.97. The average score across segments increased from 7.13 to 2.78, meeting the criteria for a 4-star rating (☆☆☆☆). This highlights the effectiveness of the proposed rehabilitation strategy.

Table 3. Example of Attribute Assessment for Segment 1

No.	Atribut	Description
A.1	Traffic Flow	
A.1.1	Vehicle Flow (LHR)	5783
A.2	Speeds	
A.2.1	Operational Speed	40 km/hour
A.2.2	Speed Limit	60 km/hour
A.2.3	Differential Speed Limits	Present
A.2.4	Speed Management / Traffic Calming	Present
A.3	Carriageway	
A.3.1	Carriageway label	Undivided road
A.3.2	Number of lanes	Four or more lanes (with median)
A.3.3	Lane width	Width (≥ 3.25m)
A.3.4	Curvature	Straight or relatively straight
A.3.5	Quality of curve	Not Applied
A.3.6	Median type	Single centerline marking
A.3.7	Skid resistance/grip	Paved - adequate
A.3.8	Road condition	Good
A.3.9	Grade	0% to <7.5%
A.3.10	Sight distance	Adequate
A.3.11	Delineation	Adequate

No.	Atribut	Description
A.3.12	Street lighting	Available
A.3.13	frontage road	Not Available
A.3.14	Centreline rumble strips	Not Available
A.4	Roadside	
A.4.1	Roadside severity - driver-side distance	1m s/d <5m
A.4.2	Roadside severity - driver-side object	Tree diameter ≥ 10cm
A.4.3	Paved shoulder - driver-side	1m s/d <2.4m
A.4.4	Roadside severity - passenger-side distance	1m s/d <5m
A.4.5	Roadside severity - passenger-side object	Tree diameter ≥ 10cm
A.4.6	Paved shoulder - passenger-side	1m s/d <2.4m
A.4.7	Shoulder rumble strips	Not Available
A.5	VRU facilities and land use	
A.5.1	Land use - driver-side	Commercial area
A.5.2	Land use - passenger-side	Commercial area
A.5.3	Area type	Urban
A.5.4	Pedestrian crossing facilities - intersecting road	A crosswalk with clear markings, equipped with traffic islands
A.5.5	Sidewalk - driver-side	Not Available
A.5.6	Sidewalk - passenger-side	Sidewalk 0m to < 1m from the edge of the road
A.5.7	School zone crossing supervisor	Zebra Crossing (ZoSS) with signs and markings
A.6	Intersection	
A.6.1	Intersection Type	Lane Merging
A.6.2	Intersection Quality	Adequate
A.6.3	Intersection Channelisation	There is channelization
A.6.4	Property Access Points	More than 1 commercial area access
A.6.5	Intersecting Road Volume	5,000 to 10,000 vehicles per day

The recommendations focus on reducing risk factors by enhancing speed management, increasing hardened shoulder width, and addressing roadside hazards. The significant improvement in safety scores highlights the potential of these interventions to achieve a safer road environment and reduce accident rates. Sustainable infrastructure maintenance and improvement plans should be implemented in all areas of the city, regardless of social class as this can lead to social segregation and affect people's mobility and safety (St. Maryam et al., 2023). Overall, this approach offers valuable insights into the design, maintenance, and improvement of infrastructure while emphasizing the need for a sustained focus on this critical aspect of urban planning.

Table 4. Recommendations for Rehabilitation Existing Conditions

Segmen Number(*)	Segmen (meter)(**)	Rating Score(***) Existing	Rating Score(****) Recommendation	Recommendations
1	200	7,20	2,67	Operational Speed, Differentiated Speed Limits, Speed Management Engineering, Hardened Shoulder Width (Right Side), Hardened Shoulder Width (Left Side), Roadside Object Distance (Right Side), Roadside Object Distance (Left Side)
2	100	6,18	2,69	Operational Speed, Differentiated Speed Limits, Speed Management Engineering, Hardened Shoulder Width (Right Side), Hardened Shoulder Width (Left Side)
3	7200	7,17	2,78	Operational Speed, Differentiated Speed Limits, Speed Management Engineering, Hardened Shoulder Width (Right Side), Hardened Shoulder Width (Left Side), Roadside Object Distance (Right Side), Roadside Object Distance (Left Side)
4	200	6,90	2,93	Operational Speed, Differentiated Speed Limits, Speed Management Engineering, Hardened Shoulder Width (Right Side), Hardened Shoulder Width (Left Side)
5	289	6,63	2,97	Operational Speed, Differentiated Speed Limits, Speed Management Engineering, Hardened Shoulder Width (Right Side), Hardened Shoulder Width (Left Side)
Ranking results		7,13	2,78	Star Rating = 4,00 (☆☆☆☆)

Table 5 serves as a summary of the analysis results to evaluate the effectiveness (Effectivity Value) and benefits (Benefit Value) of the two methods, namely iRAP (International Road Assessment Program) and Bina Marga after rehabilitation was carried out on the Karanglo-Batu road segment. A comparison of Effectiveness Value using the iRAP method shows that after rehabilitation, the effectiveness value obtained is 8.92, which is included in the effective category.

The change value (Δ iRAP) is -1.79, which means that the effectiveness of the road has decreased slightly. The main benefit of this method is related to Direct Benefits such as reducing the risk of accidents. On the other hand, in the Bina Marga method, this method produces a higher effectiveness value, namely 12.36, and is included in the very effective category. The change (Δ SRS) of 2.78 shows a significant increase in effectiveness compared to the previous condition. The interpretation obtained is that the Bina Marga method is proven to be more effective than iRAP in improving road safety in the analyzed segment.

The benefit value of the iRAP method is not identified (in the table it is recorded as "-1.79") so additional interpretation may be needed regarding its contribution to improving safety. This is different from Bina Marga which recorded a benefit value of 6.14, which indicates direct benefits such as reducing accident costs or increasing accessibility. The interpretation obtained by the Bina Marga method shows clearer and more measurable benefit values compared to iRAP.

The "Effective" and "Very Effective" categories provide insight into how well each method improves post-rehabilitation road safety. Bina Marga consistently records higher effectiveness, indicating that this approach is superior for the Karanglo-Batu segment. The Bina Marga method has higher effectiveness and more significant benefits compared to iRAP for the Karanglo-Batu segment. The iRAP method, although effective, shows a small decrease in effectiveness values after rehabilitation.

The analysis results using the iRAP method show a score of 8.92, corresponding to a 3-Star Rating (☆☆☆). Similarly, the existing condition analysis with the Bina Marga method yielded a score of 7.13, also achieving a 3-star Rating (☆☆☆). After implementing the recommended rehabilitation measures, the Bina Marga score improved significantly to 2.78, achieving a 4-star Rating (☆☆☆☆) (Smith, 2015). Conversely, survey results obtained via a smartphone with the Android application can serve as a reference or preliminary assessment for estimating the actual International Roughness Index (IRI) value (Setiadharma et al., 2018). The comparison of the iRAP and Bina Marga methods underscores their shared focus on road safety assessment, albeit with distinct approaches. The iRAP method recognized globally, leverages technology and adheres to international standards, making it widely applicable across different regions. In contrast, the Bina Marga method is specifically tailored to local needs and regulations in Indonesia, allowing for targeted implementation in national contexts.

Table 5. Recapitulation of Analysis Results for Effectivity Value and Benefit Value After Rehabilitation

Method	Effectively value	Effect Category	Δ Value	Benefit Value	Description
iRAP	35,68	Effective	8.92	-1,79	Direct Benefits
Bina Marga	12,36	Very Effective	2,78	6,14	Direct Benefits

This evaluation aligns with transportation modelling outcomes, which emphasize substantial road development achievements on National Roads, particularly in Sumatra. The strategic plan of the Directorate General of Highways aims to expand road widths to 7.0 meters, categorizing them as medium roads (Ardhiarini, 2016). Additionally, mapping existing road safety knowledge provides a comprehensive overview of global effectiveness (Mahendra et al., 2023), enabling program managers to access high-quality evidence and inform the targeted commissioning of future research.

CONCLUSION

The roadworthiness test for the Karanglo-Batu City (Karang Ploso) road section, spanning 7.99 km, demonstrated effectiveness through the use of two ranking-based analysis methods. The iRAP method achieved an effectiveness value of 35.68, categorized as effective, while the Bina Marga method yielded an effectiveness value of 31.69, also categorized as effective. After implementing the recommended improvements, the effectiveness value increased to 12.36, categorized as very effective.

In terms of benefit value, the iRAP method demonstrated more direct benefits compared to the Bina Marga method. The scoring results further highlight these differences: the iRAP method initially scored 8.92, corresponding to a 3-star rating (☆☆☆), while the Bina Marga method scored 7.13, also corresponding to a 3-star rating (☆☆☆). Following the recommended improvements, the iRAP score improved significantly to 2.78, achieving a 4-star rating (☆☆☆☆). The iRAP and Bina Marga analysis methods both provide tangible, direct benefits. In this context, "direct benefits" refer to advantages in terms of data input accuracy, sampling efficiency, and ease of implementation, contributing to enhanced road safety outcomes.

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